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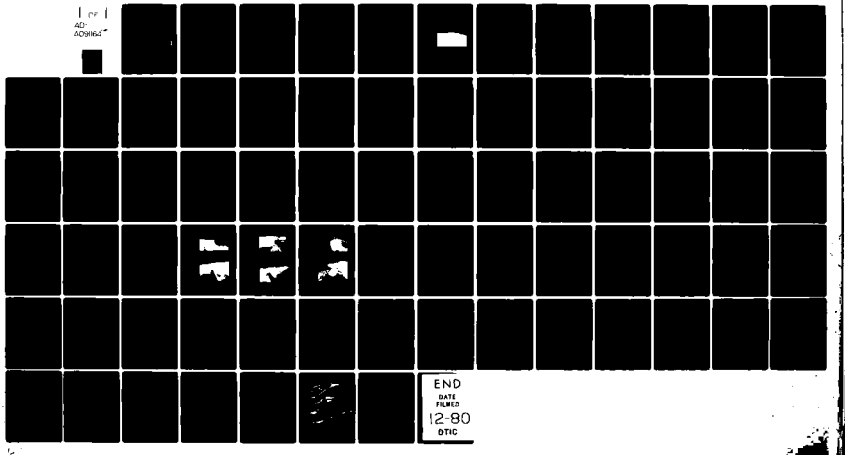
NATIONAL DAM INSPECTION PROGRAM. SPRUCE RESERVOIR DAM (NDI I.D.--ETC(U)
1980 DACW31-80-C-0022
UNCLASSIFIED NL



SUSQUEHANNA RIVER BASIN
SPRUCE RUN, UNION COUNTY

(1)

AD A091164

PENNSYLVANIA

LEVEL II

SPRUCE RESERVOIR

NDI I.D. PA-00587
DER I.D. 60-7

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DACW31-80-C-0022
PREPARED FOR

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
BALTIMORE, MARYLAND 21203

BY

D'APPOLONIA CONSULTING ENGINEERS
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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigations and analyses involving topographic mapping, subsurface investigations, material testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the inspection is intended to identify any need for such studies which should be performed by the owner.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of the dam depends on numerous and constantly changing internal and external factors which are evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The assessment of the conditions and recommendations was made by the consulting engineer in accordance with generally and currently accepted engineering principles and practices.

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Spruce Reservoir
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Union
STREAM: Spruce Run, a Secondary Tributary of the West Branch of the Susquehanna River
SIZE CLASSIFICATION: Intermediate
HAZARD CLASSIFICATION: High
OWNER: Keystone Water Company, White Deer District
DATE OF INSPECTION: April 28, 1980 and April 30, 1980

ASSESSMENT: Based on the evaluation of the existing conditions, the condition of Spruce Reservoir is considered to be fair. In view of indications of surficial slumps on the downstream face of the main embankment, combined with the observations that the embankment does not have any internal drainage system to control seepage through the embankment and the downstream slope is relatively steep (2H:1V), concern exists as to the actual location of the phreatic surface through the embankment and its effect on the stability of the dam. Based on these observations, reevaluation of the stability of the embankment is recommended.

According to the recommended criteria, intermediate size dams in the high hazard category are required to pass full probable maximum flood (PMF) without overtopping the embankment. The flood discharge capacity was evaluated according to the recommended criteria and the bypass channel spillway was found to pass 60 percent of the PMF without overtopping the embankment on the upstream side of Spruce Reservoir. For 80 percent of the PMF, it was found that flow entering the reservoir over the upstream embankment can pass through the reservoir overflow spillway without overtopping the main embankment. Because the spillway capacity (80 percent of the PMF) is less than the required capacity of full PMF, the flood discharge capacity of the dam is rated to be inadequate. Therefore, it is considered advisable that the owner retain a professional engineer to conduct additional detailed hydrological and hydraulic studies to determine the need to provide emergency spillway facilities to the reservoir.

The following recommendations should be implemented immediately or on a continuing basis.

1. The owner should immediately retain a professional engineer experienced in the design and construction of dams to reevaluate the stability of the embankment in view.

of the observations noted. The reevaluation of the dam should include, but not be limited to, subsurface investigation, materials testing, installation of instrumentation, and seepage and stability analyses.

2. In conjunction with the detailed evaluation of the dam, the crest of the dam should be surveyed and the low spots filled to design elevation.

3. Brush and trees in the bypass channel below the spillway should be removed.

4. The operational condition of the outlet pipe gate should be evaluated and necessary maintenance performed.

5. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of emergencies.

6. The dam and appurtenant structures should be inspected regularly and a formal maintenance manual should be developed for the continued maintenance of the dam.

Lawrence D. Andersen, P.E.
Vice President

July 30, 1980
Date

Approved by:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

21 Aug 80
Date

SPRUCE RESERVOIR DAM
NDI I.D. PA-487
DER I.D. 60-73
APRIL 28, 1980

Overview
(Downstream face of main embankment)

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
SPRUCE RESERVOIR
NDI I.D. PA-587
DER I.D. 60-7

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. The inspection was performed pursuant to the authority granted by The National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project

a. Dam and Appurtenances. Spruce Reservoir consists of an earth embankment approximately U-shaped in plan view, impounding an offstream reservoir. The main embankment starts from the left side of the valley (looking downstream), continues across the valley for approximately 800 feet, then turns upstream and continues approximately 3200 feet joining the earth embankment which forms the upstream end of the reservoir. The bypass channel is located between the embankment and the right side of the valley. An ogee-crested overflow weir across the bypass channel in line with the upstream end of the reservoir forms the diversion structure which diverts water through a controlled intake structure into Spruce Reservoir. Excess flow entering the reservoir is discharged through an uncontrolled outlet structure located near the right downstream corner of the reservoir. The portion of the embankment along the downstream end of the reservoir has a maximum height of approximately 46 feet from the downstream toe and a crest elevation 4 feet above the normal pool level of the reservoir. The crest level of the portion of the embankment along the upstream end of the reservoir is 2 feet above the crest level of the main embankment, providing 6 feet of freeboard to the spillway located across the bypass channel.

The outlet facilities for Spruce Reservoir consist of a concrete intake tower, a 24-inch outlet pipe, and a 16-inch supply line. Flow through these pipes is controlled by valves located at the intake tower. The 24-inch outlet pipe constitutes the emergency drawdown facility for the reservoir.

b. Location. Spruce Reservoir is located on Spruce Run in Buffalo and White Deer Townships, Union County, Pennsylvania. Plate 1 illustrates the location of the dam.

c. Size Classification. Intermediate (based on 46-foot height and 1780 acre-feet maximum storage capacity).

d. Hazard Classification. The dam is classified to be in the high hazard category. At least five houses within a one-mile downstream reach are considered to be within the potential flood plain of Spruce Reservoir. It is estimated that failure of the dam would cause large loss of life and property damage in the downstream rural residential areas.

e. Ownership. Keystone Water Company, White Deer District, (address: Mr. E. L. Guskey, Manager, White Deer District, 114 South Front Street, Milton, PA 17847).

f. Purpose of Dam. Water supply.

g. Design and Construction History. The dam was designed by American Water Works Service Company, Inc., in 1956 and constructed by the owner with completion in 1957.

h. Normal Operating Procedure. Flow into the reservoir is controlled by stop logs across an intake structure at the upstream end of the reservoir. Flow entering the reservoir is maintained at Elevation 672 (USGS Datum) which is the crest level of the uncontrolled overflow spillway.

1.3 Pertinent Data. Elevations referred to in this and subsequent sections of the report were taken from the design drawings.

a. Drainage Area	13.2 square miles
b. Discharge at Dam Site (cfs)	
Maximum known flood at dam site	Unknown
Outlet conduit at maximum pool	83+
Gated spillway capacity at maximum pool	Not applicable
Ungated spillway capacity at maximum pool	9278(1)
Total discharge capacity at maximum pool	9278

(1) Bypass channel spillway capacity based on the current available freeboard. (Reservoir spillway capacity is estimated to be 83 cfs.)

c. Elevation (USGS Datum) (feet)

Top of dam	676 (main embankment)
Maximum pool	675.9
Normal pool	672
Upstream invert outlet works	635.75
Downstream invert outlet works	630±
Maximum tailwater	Unknown
Toe of Dam	630±

d. Reservoir Length (feet)

Normal pool level	3200
Maximum pool level	3200±

e. Storage (acre-feet)

Normal pool level	1535
Maximum pool level	1780

f. Reservoir Surface (acres)

Normal pool level	61
Maximum pool level	61±

g. Dam

Type	Earth
Length	4600 feet
Height	46 feet
Top width	15 feet
Side slopes	Downstream: 2H:1V; Upstream: 2H:1V
Zoning	Yes
Impervious core	Yes
Cutoff	Yes
Grout Curtain	No

h. Regulating Outlet

Type	24-inch cast-iron pipe
Length	350± feet
Closure	Sluice gate
Access	Intake tower
Regulating facilities	Sluice gate

i.	Spillway	Bypass Channel	Reservoir
	Type	Concrete ogee	Drop inlet
	Length	212 feet	15 feet[2]
	Crest elevation	672	672
	Upstream channel	Stream	Reservoir
	Downstream channel	Bypass channel	24-inch outlet pipe

[2]Perimeter of drop inlet structure.

SECTION 2
DESIGN DATA

2.1 Design

a. Data Available. The available information was provided by the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER), and by the owner. The available information includes design drawings, correspondence, and maintenance records kept by the owner.

(1) Hydrology and Hydraulics. The available information includes the design capacity of the bypass channel spillway.

(2) Embankment. The available information consists of design drawings, construction progress reports, and the records of postconstruction grouting work provided by the owner.

(3) Appurtenant Structures. The available information includes design drawings.

b. Design Features

(1) Embankment. Plate 2 shows the plan and the typical cross section of the portion of the embankment along the upstream end of the reservoir. This portion of the embankment and the bypass channel spillway was constructed in 1916 as a diversion dam. During the construction of Spruce Reservoir in 1956, the diversion dam was utilized as a dike to form the upstream end of the reservoir. As shown in Plate 2, the typical cross section of the upstream dike consists of a homogeneous embankment with a central concrete core wall. Plate 4 shows the plan and the typical cross sections of the embankment along the bypass channel and the downstream side of the reservoir. The typical cross section is shown to be essentially a homogeneous embankment with a central impervious core section. The drawings indicate that as designed, the embankment slopes were 2H to 1V on both the upstream and downstream faces. The upstream face was protected with riprap extending from the upstream toe to the crest level, and the outside portion of the embankment along the bypass channel was provided with riprap extending vertically 10 feet up from the downstream toe.

(2) Appurtenant Structures. The appurtenant structures consist of a bypass channel, an intake structure located at the upstream end of the reservoir, and a reservoir spillway and outlet works. The bypass channel is approximately 212 feet wide at the spillway section in line with the upstream end of the reservoir,

enlarging to a width of 275 feet approximately 200 feet downstream from the spillway. The bypass channel spillway crest is at Elevation 672, with an available freeboard of 6 feet (as designed) relative to the upstream dike crest located at Elevation 678. Flow diverted by the bypass channel spillway flows through a diversion channel along the upstream dike and enters into Spruce Reservoir through an intake structure. Stop logs across the intake structure control the flow rate into the reservoir. An overflow drop inlet structure at the reservoir intake tower constitutes the reservoir spillway. Plate 5 shows the plan of the overflow section and the outlet works. The typical cross section of the dam through the outlet works and details of the outlet facilities are included in Plates 6 and 7, respectively. The outlet facilities include a 24-inch cast-iron outlet pipe and a 16-inch supply line. Flow through these pipes is controlled by sluice gates located at the intake tower.

c. Design Data

(1) Hydrology and Hydraulics. A Commonwealth report dated May 9, 1956, indicates that the bypass channel spillway was sized for a capacity of 10,290 cubic feet per second (cfs), corresponding to a runoff of 763 cfs per square mile in conformance with Commonwealth spillway design criteria applicable at the time.

(2) Embankment. Other than design drawings, the available information includes no engineering data on the design of the embankment.

(3) Appurtenant Structures. Other than design drawings, no design data are available on the appurtenant structures.

2.2 Construction. Very limited information is available on the construction of the dam. As can be inferred from the construction progress reports prepared by the owner, the construction of the dam was conducted in conformance with the specifications prepared by the designers. No reference to any construction difficulties was noted.

2.3 Operation. The operating records consist of reservoir stage records remotely monitored and recorded at the water company's treatment plant in Milton, Pennsylvania.

2.4 Other Investigations. None reported.

2.5 Evaluation

a. Availability. The available information was provided by PennDER and the owner.

b. Adequacy

(1) Hydrology and Hydraulics. Available information consists of the design capacity of the bypass channel spillway. This information is not considered to be sufficient to assess the adequacy of the spillway.

(2) Embankment. Other than design drawings, no design data are available to assess the structural design of the embankment.

(3) Appurtenant Structures. Based on the review of the design drawings, the structural design of the appurtenant structures is considered to be adequate.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Spruce Reservoir consisted of:

1. Visual inspection of the embankment, abutments, and embankment toe.

2. Visual examination of the spillway structures.

3. Evaluation of downstream area hazard potential.

Plate 8 illustrates some of the existing features of the dam.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils, and observing general maintenance conditions, vegetative cover, erosion, and other surficial features.

The embankment was found to be in fair condition. The conditions noted which require further attention are the indications of surficial slumps along the lower half of the main embankment at the downstream end of the reservoir. It appears that these conditions are caused by saturation of the poorly draining embankment surface material on a relatively steep (2H:1V) slope of the embankment. Although it is possible that a high phreatic surface through the embankment could be contributing to this condition, no noticeable seeps were found on the downstream slope of the dam that would support this observation. At this time, indications of surficial slumps are not considered to be serious relative to the overall stability of the embankment. Another condition noted was the presence of erosion in the areas where the embankment is lacking adequate vegetative cover. At the upstream side of the main embankment at its junction with the left abutment, riprap appears to have dislocated due to wave action, posing a potential for shoreline erosion. A swampy area was found at the toe level of the main embankment-left abutment junction with an associated seepage on the order of 10 to 20 gallons per minute. It was noted by the owner that swampy conditions have existed in the past and a french drain system was installed at the junction of the embankment and abutment to collect the seepage. This appears to be contributing to the swampy conditions along the toe of the dam. The present extent of the swampy condition is not considered to be serious relative to the overall stability of the dam.

The crest of the dam was surveyed relative to the bypass channel spillway crest level and the crest of the embankment along the upstream side of the reservoir was found to be up to 0.9 foot below the design crest elevation. The lowest point occurred adjacent to the bypass channel left abutment wall. The crest levels of the embankment along the bypass channel and the embankment on the downstream side of the reservoir were found to be essentially at or above the design level. The dam crest profile is illustrated in Plate 9. The downstream slopes were surveyed and found to be reasonably within the design slope of 2H to 1V.

c. Appurtenant Structures. The visible portions of the appurtenant structures were examined for deterioration and other signs of distress or obstructions that would limit flow. The structures were found to be in good condition. One condition noted was thick growth of brush and trees in the bypass channel below the spillway. Although at this time this condition is not considered to constitute a significant obstruction affecting the discharge capacity of the bypass channel, clearing brush and trees in the channel in the first 200 feet is recommended. The operational condition of the outlet pipe sluice gate was not observed.

d. Reservoir Area. The visual observations indicated no landslide activity in the vicinity of the dam. The review of the regional geology is included in Appendix F.

f. Downstream Channel. A description of the downstream channel is included in Section 1.2d.

3.2 Evaluation. The dam was found to be in fair condition. Although the observed conditions are not considered to be serious relative to the overall stability of the dam at this time, further investigation of the causes of slumping on the downstream face of the dam is considered necessary. In conjunction with this further investigation, measures should be taken to prevent erosion of the downstream slope of the dam. Also, brush and trees in the bypass channel for at least 200 feet below the spillway should be cleared.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. There are no formal operating procedures for the dam. The reservoir is normally maintained at the overflow spillway crest level by regulating the inflow into the reservoir. Water levels in the reservoir are remotely monitored and recorded at the water company treatment plant in Milton, Pennsylvania.

4.2 Maintenance of the Dam. The downstream slope of the dam is covered with small brush up to 2 feet high. It appears that taller brush is periodically cut. In areas with poor vegetative cover, surficial erosion of the embankment material was noted. The brush may tend to inhibit the growth of grass which would control this erosion.

4.3 Maintenance of Operating Facilities. The operating facilities were found to be adequately maintained. Because the owner was concerned about the operational condition of the reservoir outlet pipe sluice gate, the operational condition of the gate was not observed.

4.4 Warning System. No formal warning system exists for the dam. However, as previously mentioned, reservoir levels are remotely monitored at the water treatment plant. Telephone communication is available via residences in the vicinity of the dam site.

4.5 Evaluation. The maintenance condition of the dam is considered to be fair. Implementation of measures to control embankment erosion and evaluation of the operational condition of the outlet pipe sluice gate is recommended.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Spruce Reservoir has a direct watershed of approximately 30 acres and impounds a reservoir with a surface area of 61 acres at normal pool level. The bypass channel passes flow from a watershed of 13.2 square miles. The capacity of the bypass channel spillway, based on the available head relative to the low spot on the embankment along the upstream end of the reservoir, was determined to be 9278 cfs as indicated in the computer output in Appendix D.

b. Experience Data. As previously stated, Spruce Reservoir is classified as an intermediate size dam in the high hazard category. Under the recommended criteria for evaluating emergency flood discharge capacity, such impoundments are required to pass full PMF.

The PMF inflow hydrograph for the bypass channel was determined utilizing the Dam Safety Version of the HEC-1 computer program developed by the Hydrologic Engineering Center of the U.S. Army, Corps of Engineers. The PMF hydrograph was found to have a peak flow of 14,777 cfs. This capacity was found to be in excess of the bypass channel spillway capacity, indicating that the flood would spill into the reservoir. The portion of the inflow hydrograph in excess of the capacity of the bypass channel spillway was diverted into the reservoir. The diverted flow was routed through Spruce Reservoir starting from normal pool level. Computer input and a summary of computer output are included in Appendix D.

c. Visual Observations. On the dates of inspection, no conditions were observed that would indicate that the capacity of the bypass channel spillway would be significantly reduced in the event of a flood. However, as previously noted, clearing of brush and trees from the bypass channel is recommended.

For the reservoir drop inlet spillway, which is the only spillway facility for the reservoir, potential exists for blockage of the drop inlet or the 24-inch outlet pipe of the spillway by debris during major floods when the upstream dike may overtop, carrying debris into the reservoir. Although in evaluating the adequacy of the reservoir spillway no reduction in the discharge capacity due to blockage was considered, the owner should conduct additional detailed hydrologic and hydraulic studies to determine the need to provide emergency spillway facilities to the reservoir.

d. Overtopping Potential. Various percentages of the PMF inflow hydrograph were routed through the bypass channel spillway, and it was found to pass 60 percent of the PMF without overtopping the low point on the upstream embankment. At full PMF, it was found that the embankment along the upstream side of the reservoir would be overtopped for a duration of 8.75 hours with a maximum depth of 1.3 feet over the low spot of the upstream embankment. Flows entering into Spruce Reservoir (at greater than 60 percent of the PMF) were routed through the outlet facilities, and it was found that the reservoir can pass 80 percent of the PMF without overtopping. For full PMF, the embankment would be overtopped for a duration of 5 hours with a maximum depth of 0.5 foot over a low spot along the crest of the main embankment.

e. Spillway Adequacy. The flood discharge capacity of the dam (80 percent of the PMF) was found to be less than the recommended capacity of full PMF. Therefore, the flood discharge capacity is rated as inadequate. Because the capacity is greater than 50 percent of the PMF, it is not considered to be seriously inadeqate.

As previously noted, the owner should to determine the need to provide emergency spillway facilities to the reservoir.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

(1) Embankment. As discussed in Section 3, the field observations indicated signs of surficial slumping which raised concern as to the continued stability of the dam. Therefore, further investigation of the stability of the dam in view of the observed conditions is recommended.

(2) Appurtenant Structures. The structural performance of the spillway structures and the bypass channel is considered to be satisfactory.

b. Design and Construction Data

(1) Embankment. As can be determined from review of the available information, it appears that the design of the embankment was based on experience. The available design and construction information does not provide any quantitative data to aid in the assessment of stability. No references were found as to whether the design included materials testing or stability and seepage analyses. Since the embankment design lacks a positive internal drainage system, some concern exists as to the location of the phreatic line through the embankment as it affects the stability. Although at this time no signs were observed to indicate that the phreatic surface is intersecting the downstream slope of the dam, in view of the indications of surficial slumping on the downstream slope of the embankment combined with the relatively steep downstream slope (2H:1V), further investigation of the stability of the dam is considered to be advisable.

(2) Appurtenant Structures. Based on the review of the design drawings, the structural design of the appurtenant facilities is considered to be adequate.

c. Operating Records. The structural stability of the dam is not considered to be affected by the operational features of the dam. The reservoir operating records are kept by the owner.

d. Post-Construction Changes. The available records indicate that a postconstruction remedial grouting program was undertaken in 1958 to control a seepage condition which existed at the junction of the main embankment and left abutment. Records indicate that approximately 30 holes were drilled and grouted.

e. Seismic Stability. In view of the concern that exists as to the static stability of the dam, the seismic stability of the dam is considered to be questionable. Therefore, the seismic stability of the dam should be reassessed in conjunction with further investigation and evaluation of the embankment.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment

a. Assessment. The visual observations indicate that Spruce Reservoir is in fair condition. Indications of surficial slumps along the lower half of the main embankment are not considered to be a serious threat to the overall stability of the dam at this time. However, considering that the embankment lacks an internal drainage system to control seepage through the embankment and the downstream slope is considered to be relatively steep (2H:1V), further investigation of the stability of the dam in view of the observed conditions is recommended.

The flood discharge capacity of the dam was evaluated according to the recommended criteria and was found to pass 80 percent of the PMF without overtopping the main embankment of the reservoir. This capacity is less than the recommended spillway capacity of full PMF, which was based on the size and downstream hazard classification of the dam. Therefore, the spillway capacity is classified to be inadequate. However, because the spillway capacity is in excess of 50 percent of the PMF, it is not considered to be seriously inadequate. As noted before, the owner is advised to consider retaining a professional engineer to conduct additional detailed hydrological and hydraulic studies to determine the need to provide emergency spillway facilities to the reservoir.

b. Adequacy of Information. The available information, in conjunction with visual observations, is considered to be sufficient to make a reasonable assessment of the condition of the dam.

c. Urgency. The following recommendations should be implemented immediately or on a continuing basis.

d. Necessity for Additional Data. In view of the conditions described above it is recommended that the owner should retain an experienced professional engineer to investigate the stability of the embankment.

7.2 Recommendations/Remedial Measures. It is recommended that the following recommendations be implemented immediately or on a continuing basis:

1. The owner should immediately retain a professional engineer experienced in the

design and construction of dams to reevaluate the stability of the embankment in view of the observations noted. The reevaluation of the dam should include, but not be limited to, subsurface investigation, materials testing, installation of instrumentation, and seepage and stability analyses.

2. In conjunction with the detailed evaluation of the dam, the crest of the dam should be surveyed and the low spots filled to design elevation.

3. Brush and trees in the bypass channel below the spillway should be removed.

4. The operational condition of the outlet pipe gate should be evaluated and necessary maintenance performed.

5. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of emergencies.

6. The dam and appurtenant structures should be inspected regularly and a formal maintenance manual should be developed for the continued maintenance of the dam.

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Spruce Reservoir COUNTY Union STATE Pennsylvania ID# NDI I.D. PA-487 DER I.D. 60-7

TYPE OF DAM Earth HAZARD CATEGORY High

DATE(S) INSPECTION April 28, 1980 WEATHER Rainy TEMPERATURE 50s

POOL ELEVATION AT TIME OF INSPECTION 669.4± M.S.L. TAILWATER AT TIME OF INSPECTION 626± M.S.L.

INSPECTION PERSONNEL:

B. Erel

W. T. Chan

REVIEW INSPECTION PERSONNEL:
(April 30, 1980)

E. D'Appolonia

L. D. Andersen

J. H. Poellot

OWNER'S REPRESENTATIVE:

Mr. Bruce E. Juergens,
Director, Engineering
Mr. Edward N. Russell
Production Superintendent
Mr. William E. Hutcheson
Director of Risk and Materials
Management

B. Erel

B. Erel RECORDER

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	There are indications of surficial sloughing and erosion along the embankment at the downstream side of the reservoir. See Plate 8 for location.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	See Plate 9.	
RIPRAP FAILURES	See Plate 8 for locations of shoreline erosion.	Adequate riprap should be provided at areas where shoreline erosion is occurring.

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No signs of distress.	
ANY NOTICEABLE SEEPAGE	A swampy area exists along the toe of the main embankment in the vicinity of its junction with the left abutment. An associated seepage is estimated to be 10 to 20 gallons per minute.	
STAFF GAGE AND RECORDER	Reservoir levels are remotely monitored and recorded at the water treatment plant.	
DRAINS	None	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Only the downstream end of the pipe was visible.	
INTAKE STRUCTURE	Submerged	
OUTLET STRUCTURE	Outlet pipe discharges into a plunge pool.	
OUTLET CHANNEL	Earth channel	
EMERGENCY GATE	Flow through the outlet pipe is controlled by a sluice gate at the outlet tower. The operational condition of the sluice gate was not observed.	The owner should evaluate the operational condition of the outlet pipe sluice gate and perform necessary maintenance.

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Bypass channel spillway weir was submerged. The structural condition could not be assessed.	
APPROACH CHANNEL	Submerged	
DISCHARGE CHANNEL	Earth channel partially blocked by vegetation.	
BRIDGE AND PIERS	None	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not applicable	
APPROACH CHANNEL	Not applicable	
DISCHARGE CHANNEL	Not applicable	
BRIDGE PIERS	Not applicable	
GATES AND OPERATION EQUIPMENT	Not applicable	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	

VISUAL INSPECTION
PHASE I
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderately steep. No significant shoreline erosion was noted.	
SEDIMENTATION	Unknown	
UPSTREAM RESERVOIRS	None	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	No features pertinent to the safety of the dam.	
SLOPES	No features pertinent to the safety of the dam.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Approximately 5 homes within a one-mile reach downstream from the dam are considered to be within the potential flood plain of Spruce Reservoir in the event of a dam failure. Population: approximately 20.	

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
AND HYDROLOGIC AND HYDRAULIC
PHASE I

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Spruce Reservoir

ID# NDI I.D. PA-487
DER I.D. 60-7

ITEM	REMARKS
AS-BUILT DRAWINGS	Available in Commonwealth files.
REGIONAL VICINITY MAP	See Plate 1.
CONSTRUCTION HISTORY	The dam was designed and constructed by American Water Works Service Company, Inc., with completion in 1957.
TYPICAL SECTIONS OF DAM	See Plates 3 and 4.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See Plates 5, 6, and 7.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Rainfall and reservoir records are maintained by the owner.
DESIGN REPORTS	None prepared
GEOLOGY REPORTS	None prepared
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None reported
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None reported

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None reported
BORROW SOURCES	Unknown
MONITORING SYSTEMS	The reservoir level is remotely monitored and recorded at the water company's treatment plant in Milton, Pennsylvania.
MODIFICATIONS	None reported
HIGH POOL RECORDS	Flow into Spruce Reservoir is controlled.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None reported
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None reported
MAINTENANCE OPERATION RECORDS	Maintained by the owner.
SPILLWAY PLAN SECTIONS DETAILS	See Plate 2.
OPERATING EQUIPMENT PLANS AND DETAILS	See Plate 7.

CHECKLIST
ENGINEERING DATA
HYDROLOGIC AND HYDRAULIC

DRAINAGE AREA CHARACTERISTICS: 13.2 square miles (woodlands)

ELEVATION, TOP OF NORMAL POOL AND STORAGE CAPACITY: 672 (1535 acre-feet)

ELEVATION, TOP OF FLOOD CONTROL POOL AND STORAGE CAPACITY: 676 (1780 acre-feet)

ELEVATION, MAXIMUM DESIGN POOL: 676

ELEVATION, TOP OF DAM: 676 (as designed); 675.8 (measured low spot)

SPILLWAY: (BYPASS CHANNEL SPILLWAY)

a. Elevation 672

b. Type Ogee overflow section

c. Width 212 feet (perpendicular to flow direction)

d. Length Not applicable

e. Location Spillover Adjacent to spillway

f. Number and Type of Gates None

OUTLET WORKS:

a. Type 24-inch cast-iron pipe

b. Location Right of center of main embankment

c. Entrance Inverts 635.7

d. Exit Inverts 630±

e. Emergency Drawdown Facilities 24-inch outlet pipe

HYDROMETEOROLOGICAL GAGES:

a. Type Rainfall gage

b. Location Dam site

c. Records Maintained by the owner

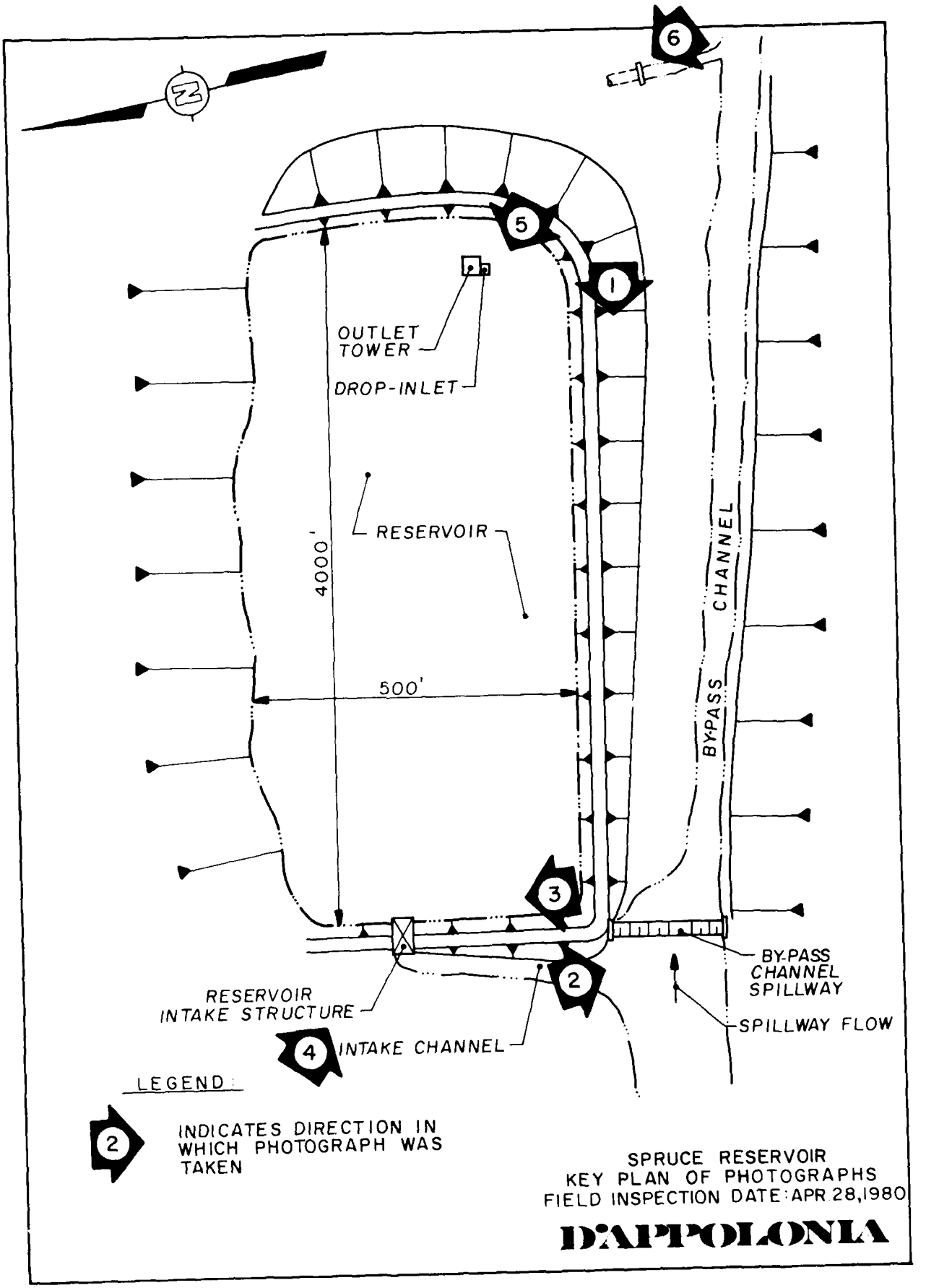
MAXIMUM NONDAMAGING DISCHARGE: 9300± cfs (bypass channel spillway capacity)

APPENDIX C

PHOTOGRAPHS

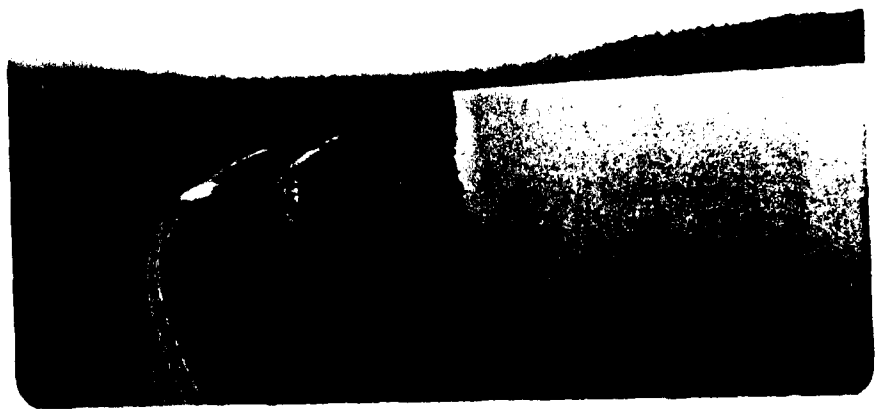
LIST OF PHOTOGRAPHS
SPRUCE RESERVOIR DAM
NDI I.D. PA-487
DER I.D. 60-7
APRIL 28, 1980

PHOTOGRAPH NO.	DESCRIPTION
1	Crest of dam (looking upstream) along bypass channel (bypass channel left of crest).
2	Bypass channel overflow section.
3	Upstream diversion dike. Righthand side: reservoir. Lefthand side: diversion channel.
4	Reservoir intake structure. Foreground: diversion channel. Background: reservoir.
5	Reservoir outlet structure.
6	Downstream end of reservoir outlet pipe.



SPRUCE RESERVOIR
KEY PLAN OF PHOTOGRAPHS
FIELD INSPECTION DATE: APR 28, 1980

D'APPOLONIA



Photograph No. 1

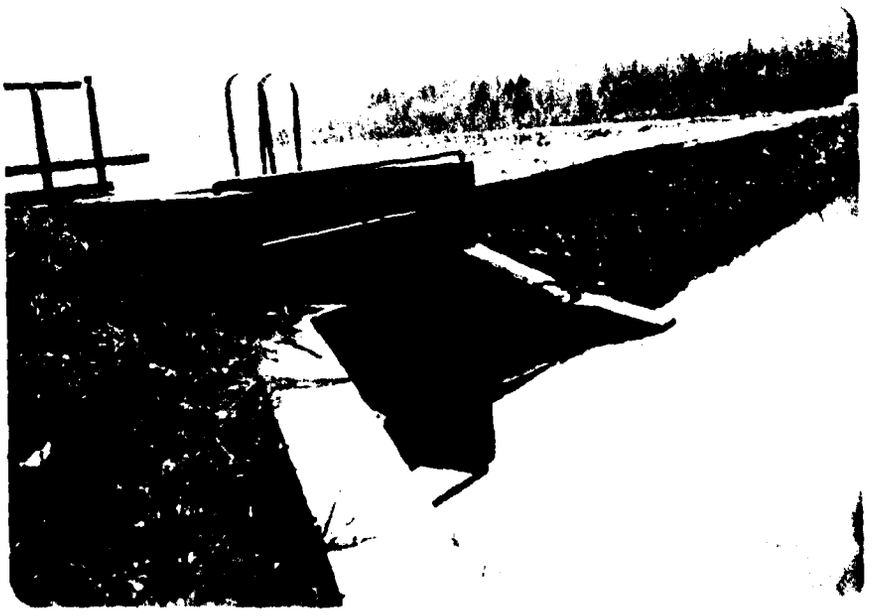
Crest of dam (looking upstream) along bypass channel (bypass channel left of crest).

Photograph No. 2

Bypass channel overflow section.

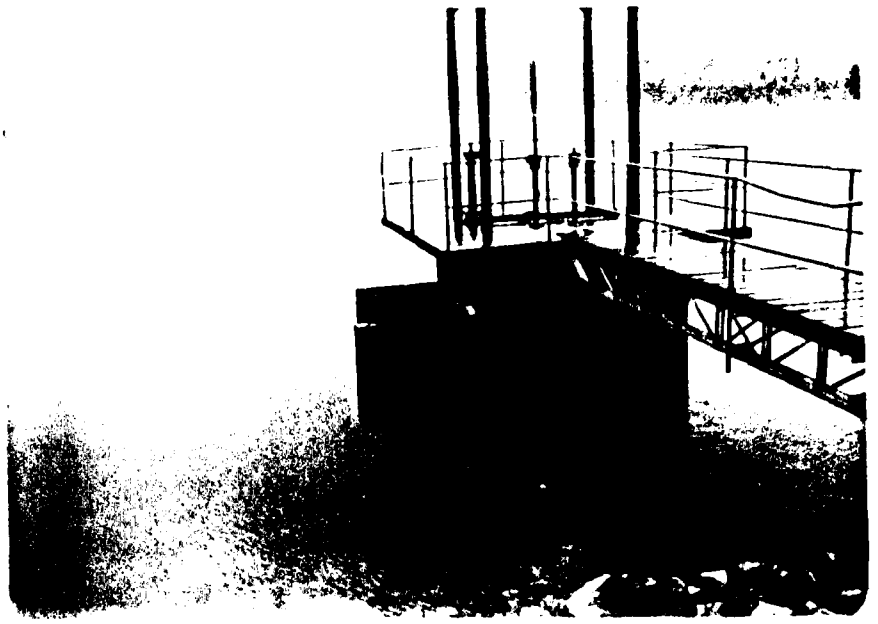
Photograph No. 3

Upstream diversion dike. Righthand side: reservoir. Lefthand side: diversion channel.



Photograph No. 4

Principal intake structure. Foreground: diversion channel. Background: reservoir.



Photograph No. 5

Reservoir outlet structure.

Photograph No. 6

Reservoir outlet pipe.

APPENDIX D

HYDROLOGY AND HYDRAULICS ANALYSES

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: Spruce Reservoir (NDI I.D. PA-587)

PROBABLE MAXIMUM PRECIPITATION (PMP) = 23.0 INCHES/24 HOURS[1]

STATION	1	2	3	4	5
Station Description	Diversion Dike	Diversion Spillway	Spruce Reservoir		
Drainage Area (square miles)	13.2	-	-0		
Cumulative Drainage Area (square miles)	13.2	13.2	13.2		
Adjustment of PMF for Drainage Area (%)[2]	(ZONE 2)				
6 Hours	117	-	-		
12 Hours	127	-	-		
24 Hours	141	-	-		
48 Hours	151	-	-		
72 Hours	-	-	-		
Snyder Hydrograph Parameters					
Zone[3]	18	-	-		
C_p/C_t[4]	0.50/2.10	-	-		
L (miles)[5]	9.9	-	-		
L_{ca} (miles)[5]	3.6	-	-		
$t_p = C_t(L \cdot L_{ca})^{0.3}$ (hours)	6.1	-	-		
Spillway Data					
Crest Length (ft)	-	212	See spillway rating calculation		
Freeboard (ft)	-	5.1			
Discharge Coefficient	-	3.8			
Exponent	-	1.5			

[1] Hydrometeorological Report 33 (Figure 1), U.S. Army, Corps of Engineers, 1956.

[2] Hydrometeorological Report 33 (Figure 2), U.S. Army, Corps of Engineers, 1956.

[3] Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (C_p and C_t).

[4] Snyder's Coefficients.

[5] L = Length of longest water course from outlet to basin divide.
L_{ca} = Length of water course from outlet to point opposite the centroid of drainage area.

DIVERSION DIKE STORAGE VS. ELEVATION

ELEVATION	ΔH, FEET	AREA (ACRES)[1]	ΔVOLUME (ACRE-FEET)[2]	STORAGE (ACRE-FEET)
672	8	0.9	40.1	0
680		11.0		40.1

[1] Planimetered from USGS maps.

[2] $\Delta Volume = \Delta H/3 \ (A_1 + A_2 + \sqrt{A_1 A_2})$.

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION   01 APR 7
**********
    1                 A1       SNYDER UNIT HYDROGRAPH,FLOOD ROUTING AND DAM OVERTOPPING ANALYSES
    2                 A2       SPRUCE RUN DAM,UNION COUNTY,NDI-PA.587                PROJECT NO.79-543-24
    3                 A3       FOR 20%,30%,40%,50%,60%,70%,80%,90%, AND 100% PMF
    4                 N     300         1       15        0        0        0        0        0       -4        0
    5                 N1      5
    6                 J       1         9        1
    7                 J1   0.20      0.30     0.40     0.50     0.60     0.70     0.80     0.90     1.00
    8                 K       0         1                                            1
    9                 K1       CALCULATION OF SNYDER INFLOW HYDROGRAPH TO SPRUCE RUN DAM
   10                 A       1         1     13.2                13.2                                  1
   11                 P              93.0      117      127      141      151
   12                 I                                                          1.0      .05          0.00122
   13                 W    6.13      3.50
   14                 X    -1.0     -0.05      2.0
   15                 K       1         2                                            1
   16                 K1       ROUTING FLOW THROUGH SPRUCE RUN DAM (NDI-I.D.PA.587)
   17                 Y                                          1        1
   18                 Y1      1                                                  -672.0
   19                 SA   0.9      11.0
   20                 SE 672.0     680.0
   21                 SS 672.0     212.0      3.8      1.5
   22                 SD 677.1       2.7      1.5    800.0
   23                 SL  50.0     425.0    675.0    750.0    800.0
   24                 SV 677.1     677.7    678.0    678.2    679.2
   25                 K      91        4                                            1
   26                 K1       DIVERT HYDROGRAPH ABOVE ELEVATION 677.1 DAM CREST LOWEST SPOT
   27                 *       3    9278.4   16[illegible].0                1        0
   28                 *3 9278.    10343.    11821.    13299.    14777.
   29                 *4   0.0    0.0873    0.1777    0.2522    0.2904
   30                 K      90        5
   31                 K1       RETRIEVE DIVERTED HYDROGRAPH TO SPRUCE RUN RESERVOIR
   32                 K       1        4                                            1
   33                 K1       ROUTING DIVERTED FLOW THROUGH SPRUCE RUN RESERVOIR
   34                 Y                                          1        1
   35                 Y1      1                                                  -672.0       -1
   36                 Y4 672.0     672.5     673.0     673.5     674.0     675.0     676.0     677.0     678.0     680.0
   37                 Y5   0.0      17.1      48.3      78.8      79.2      80.0      80.9      81.7      82.5      84.1
   38                 SA  60.6      70.0
   39                 SE 672.0     680.0
   40                 SS 672.0      15.0      3.2       1.5
   41                 SD 675.9       2.7      1.5    4400.0
   42                 SL 400.0     800.0    1000.0    1500.0    2100.0    2700.0    3000.0    3200.0    4000.0    4400.0
   43                 SV 675.9     676.0     676.1     676.2     676.3     676.4     676.5     676.6     676.7     676.8
   44                 K      99
```

COMPUTER INPUT OVERTOPPING ANALYSIS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .20	RATIO 2 .30	RATIO 3 .40	RATIO 4 .50	RATIO 5 .60	RATIO 6 .70	RATIO 7 .80	RATIO 8 .90	RATIO 9 1.00
HYDROGRAPH AT	1	13.20 (34.19)	1	2955. (83.69)	4433. (125.53)	5911. (167.37)	7388. (209.21)	8866. (251.06)	10344. (292.90)	11821. (334.74)	13299. (376.59)	14777. (418.43)
ROUTED TO	2	13.20 (34.19)	1	2955. (83.67)	4432. (125.51)	5910. (167.35)	7387. (209.19)	8866. (251.05)	10343. (292.88)	11821. (334.72)	13299. (376.57)	14777. (418.43)
DIVERSION TO	3	13.20 (34.19)	1	0. (0.00)	0. (0.00)	0. (0.00)	0. (0.00)	0. (0.00)	93. (2.63)	452. (12.79)	1014. (28.71)	1597. (45.21)
HYDROGRAPH AT	4	13.20 (34.19)	1	2955. (83.67)	4432. (125.51)	5910. (167.35)	7387. (209.19)	8866. (251.05)	10250. (290.24)	11369. (321.93)	12285. (347.87)	13180. (373.22)
HYDROGRAPH AT	3	0.00 (0.00)	1	0. (0.00)	0. (0.00)	0. (0.00)	0. (0.00)	0. (0.00)	93. (2.63)	452. (12.79)	1014. (28.71)	1597. (45.21)
ROUTED TO	4	0.00 (0.00)	1	0. (0.00)	0. (0.00)	0. (0.00)	0. (0.00)	0. (0.00)	7. (.20)	75. (2.13)	182. (5.16)	1485. (42.04)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	672.00	672.00	677.10
STORAGE	0.	0.	16.
OUTFLOW	0.	0.	9278.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.29	674.38	0.00	4.	2955.	0.00	45.50	0.00
.33	675.12	0.00	6.	4432.	0.00	45.50	0.00
.40	675.78	0.00	9.	5910.	0.00	45.50	0.00
.50	676.38	0.00	12.	7387.	0.00	45.50	0.00
.63	676.95	0.00	15.	8866.	0.00	45.50	0.00
.71	677.45	.35	18.	10343.	3.50	45.50	0.00
.81	677.84	.74	21.	11821.	5.75	45.50	0.00
.93	678.14	1.04	23.	13299.	7.25	45.50	0.00
1.00	678.40	1.30	25.	14777.	8.75	45.50	0.00

SUMMARY OF ROUTING THROUGH BYPASS CHANNEL SPILLWAY

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	672.00	672.00	675.90
STORAGE	0.	0.	245.
OUTFLOW	0.	0.	81.

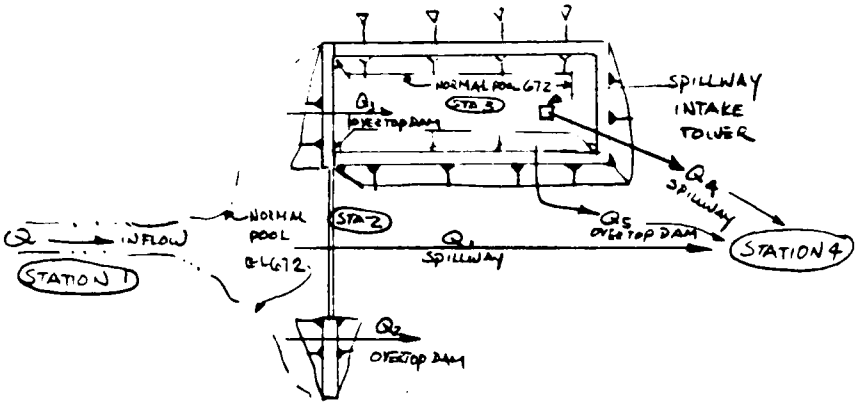
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	672.00	0.00	0.	0.	0.00	0.00	0.00
.30	672.00	0.00	0.	0.	0.00	0.00	0.00
.40	672.00	0.00	0.	0.	0.00	0.00	0.00
.50	672.00	0.00	0.	0.	0.00	0.00	0.00
.60	672.00	0.00	0.	0.	0.00	0.00	0.00
.70	672.21	0.00	13.	7.	0.00	47.00	0.00
.80	673.44	0.00	89.	75.	0.00	47.75	0.00
.90	676.04	.14	254.	182.	2.50	48.50	0.00
1.00	676.42	.52	279.	1485.	5.50	46.25	0.00

SUMMARY OF ROUTING THROUGH SPRUCE RESERVOIR

D'APPOLONIA
CONSULTING ENGINEERS, INC

By WTC Date 7/11/80 Subject SPRUCE RUN DAM & RESERVOIR Sheet No. 1 of 3
Chkd By ___ Date ___ DIVERSON FLOW Proj. No. 79-543-24

DETERMINE DIVERSON FLOW



DAM CREST (LOWEST) = 677.10
Spillway crest = 672.00
THDVR = Q_S = $C_1 L_1 H_1^{1.5}$ = $(3.8)(212)(5.1)^{1.5}$ = 9278 cfs

FROM PRELIMINARY HEC 1 RUNS, $Q_3 > 0$ @ 65% PMF OR GREATER

LAKE ELEVATION	DISCHARGE						+3 CARD	+4 CARD
	$Q_1 = C_1 L_1 H_1^{1.5} = (3.8)(212)(H_1)^{1.5}$		$Q_2 = C_2 L_2 H_2^{1.5} = (2.7)(200)(H_2)^{1.5}$		Q (3)	$Q - Q_1 - Q_2$	DISQ(i)	FRACD(i)
	H_1 (1)	Q_1	H_2 (2)	Q_2		Q_3	$Q - Q_S$	$\frac{Q_3}{Q - Q_S}$
	FT	cfs	FT	cfs	cfs	cfs	cfs	
677.45	5.45	10250	—	—	10343	93	1065	0.0873
677.84	5.84	11369	—	—	11821	452	2543	0.1777
678.14	6.14	12257	0.14	28	13299	1014	4021	0.2522
678.40	6.40	13044	0.40	137	14777	1597	5499	0.2904

→ DVRMX, SET @ 1600 cfs

NOTES
(1) H_1 = LAKE ELEVATION − 672
(2) H_2 = LAKE ELEVATION − 678 (ELEV. 678 = CREST LEVEL OF EMBANKMENT, RIGHT OF SPILLWAY)
(3) Q = INFLOW OBTAINED FROM HEC 1 RUNS @ 70%, 8% 9% and 100% PMF

$$H_T = \left[\frac{(25204)(1+0.5)}{(2)^4} + \frac{(466.18)(0.02)^2(450)}{(2)^{\frac{16}{3}}}\right]\left(\frac{Q_p}{10}\right)^2$$

(0.5 = ENTRANCE LOSS COEF.; 0.02 = C.I PIPE)

$$Q_p = 11.55\sqrt{H_T}$$

$$= 11.55\sqrt{\text{LAKE ELEVATION} - 627} \quad \text{——— EQ-2}$$

FOR $Q_W = Q_p$

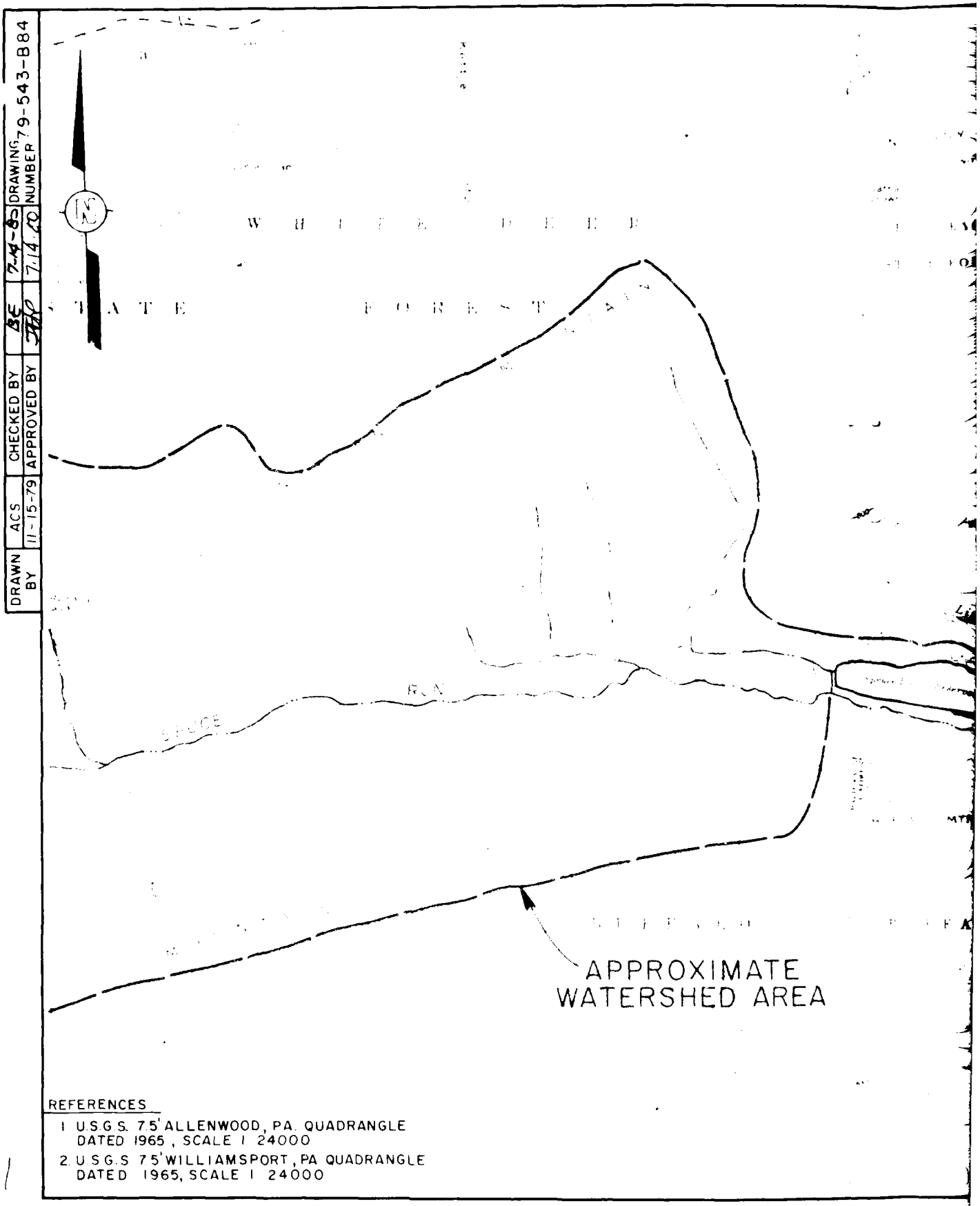
$$(48.3)(\text{LAKE ELEVATION} - 672)^{1.5} = (11.55)\sqrt{\text{LAKE ELEVATION} - 627}$$

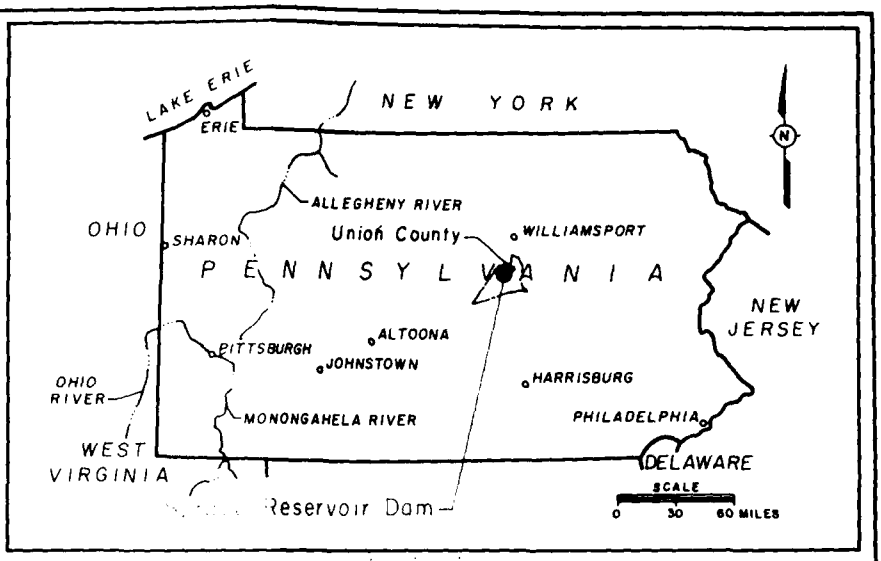
then LAKE ELEVATION = 673.4 say 673.5

LAKE ELEVATION	EQ-1 Q_W cfs	EQ-2 Q_p cfs	Q_4 SPILLWAY DISCHARGE cfs	REMARK	
672	0	—	0	SPILLWAY CREST	WEIR CONTROL
672.5	17.1	—	17.1		
673	48.3	—	48.3		
673.5	88.7	78.8	78.8	CONTROL CHANGED ▽	
674	—	79.2	79.2		PIPE CONTROL
675	—	80.0	80.0		
676	—	80.9	80.9	DAM CREST	
677	—	81.7	81.7		
678	—	82.5	82.5		
679	—	83.3	83.3		

APPENDIX E

PLATES


DRAWN BY ACS 11-15-79
CHECKED BY BE 7-4-80
APPROVED BY JHP 7/14/80
DRAWING NUMBER 79-543-B84
N
WHITE DEER
STATE FOREST
RUN
SPRUCE
APPROXIMATE
WATERSHED AREA
REFERENCES
1 U.S.G.S. 7.5' ALLENWOOD, PA. QUADRANGLE
DATED 1965, SCALE 1 24000
2 U.S.G.S 7.5' WILLIAMSPORT, PA QUADRANGLE
DATED 1965, SCALE 1 24000



KEY PLAN

SPRUCE RESERVOIR DAM

IMATE
ED AREA

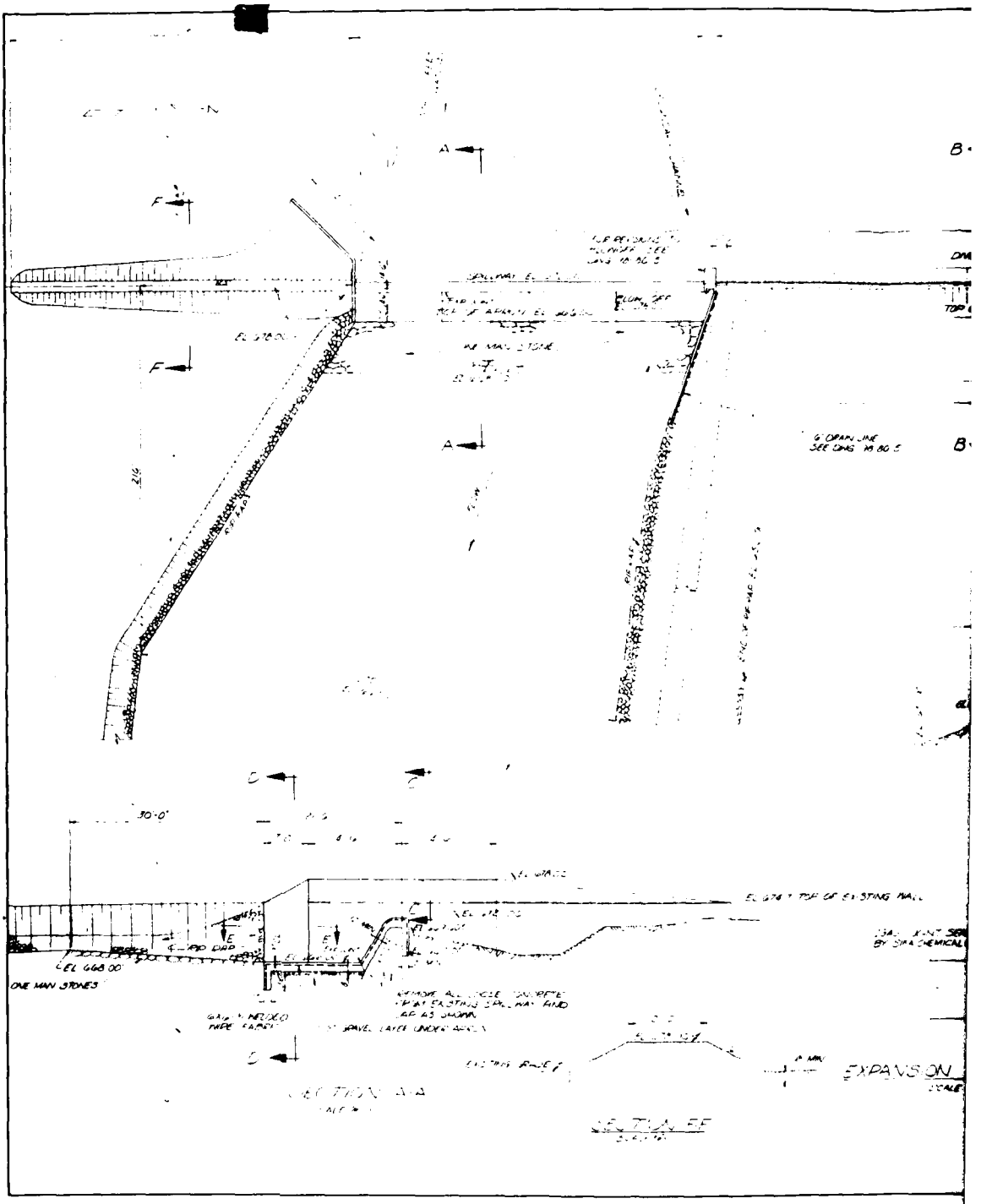
SCALE
0 2000 4000 6000 FEET

PLATE I

SPRUCE RESERVOIR DAM
VICINITY, FLOOD PLAIN & WATERSHED MAP

DAPPOLONIA

DRAWN BY	mel	CHECKED BY	BE	12-9-80	DRAWING NUMBER 79-543-885
	6-11-80	APPROVED BY	[illegible]	7-14-80	



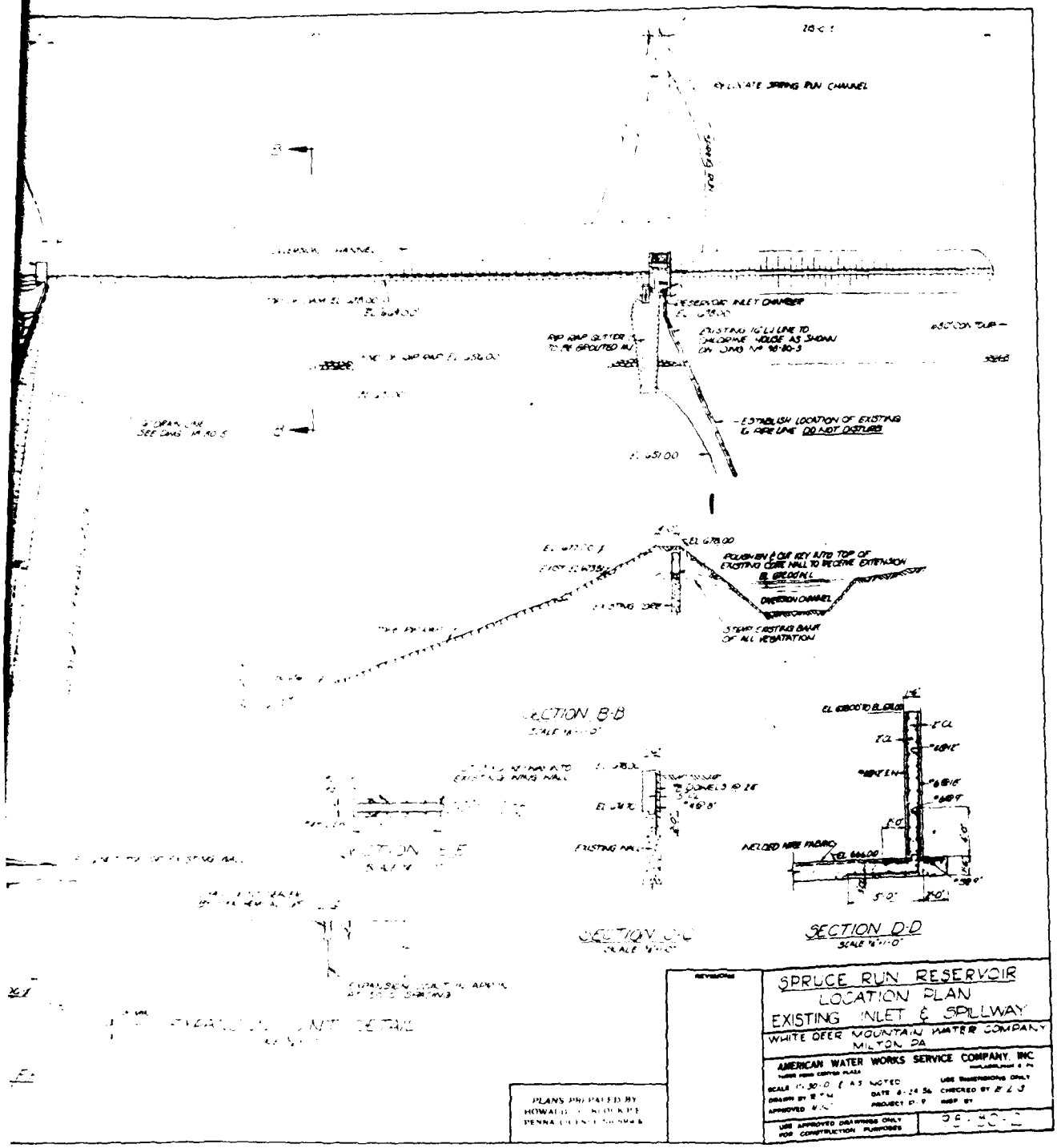
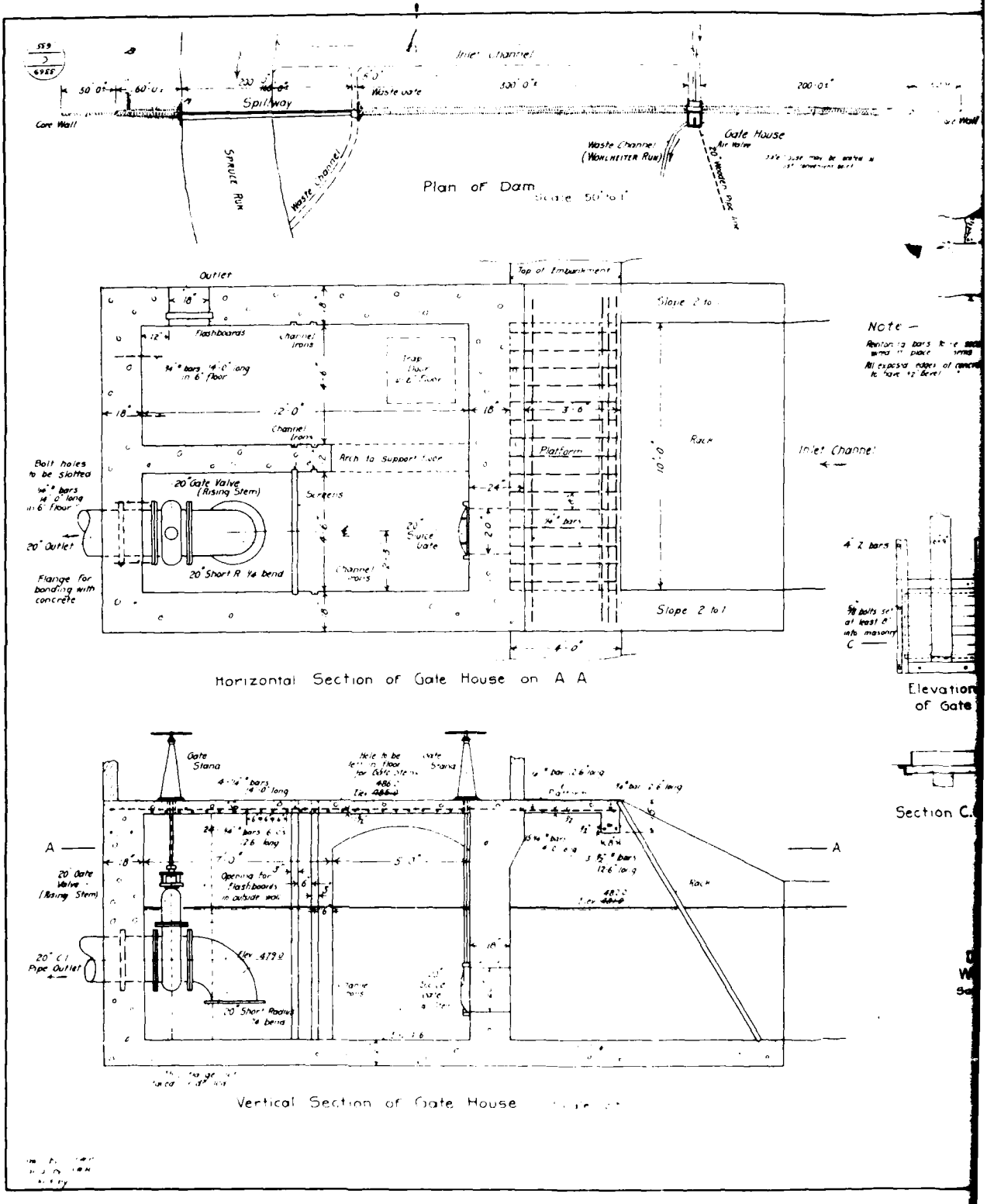
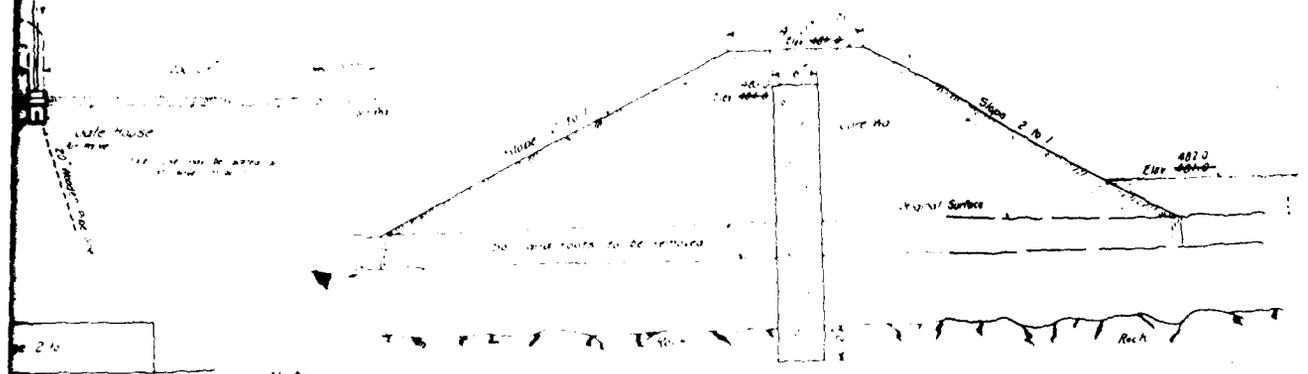


PLATE 2

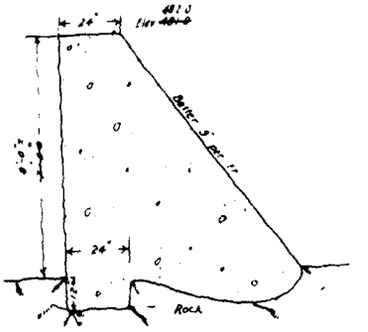
D'APPOLONIA

DRAWN BY	CHECKED BY	DRAWING NUMBER
6-11-80	7-14-80	79-543-B86

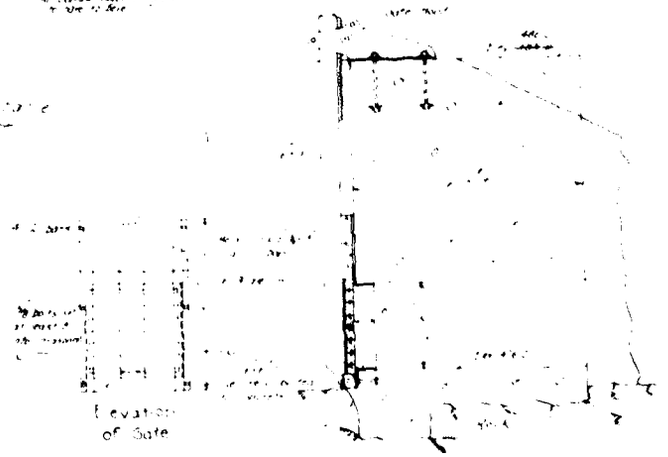




Maximum Section of Embankment



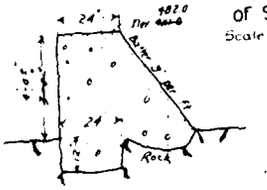
Maximum Section



Elevation of Gate

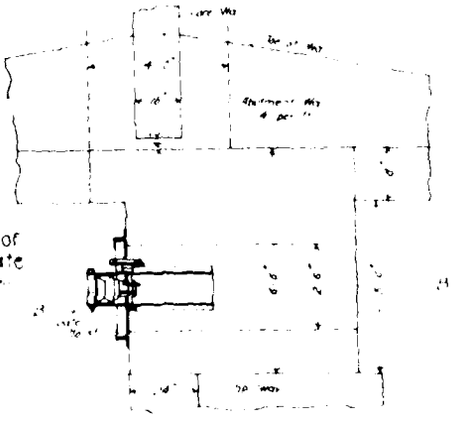
Section B-B

Details of Spillway



Minimum Section

Section C-C



Details of Waste Gate

Plan

WHITE DEER MOUNTAIN WATER CO.
MILTON, PA.

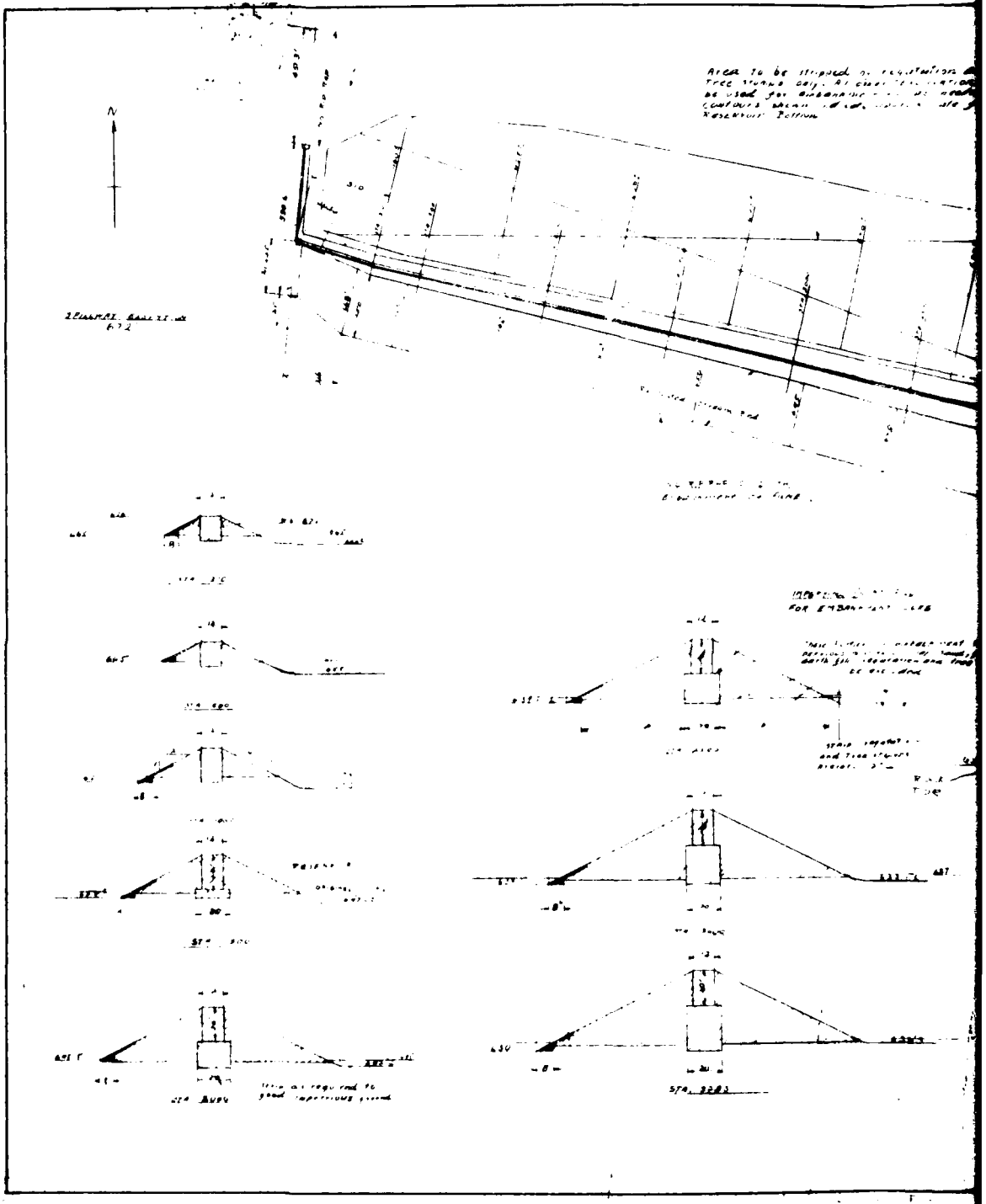
SPRUCE RUN DAM AND GATE HOUSE

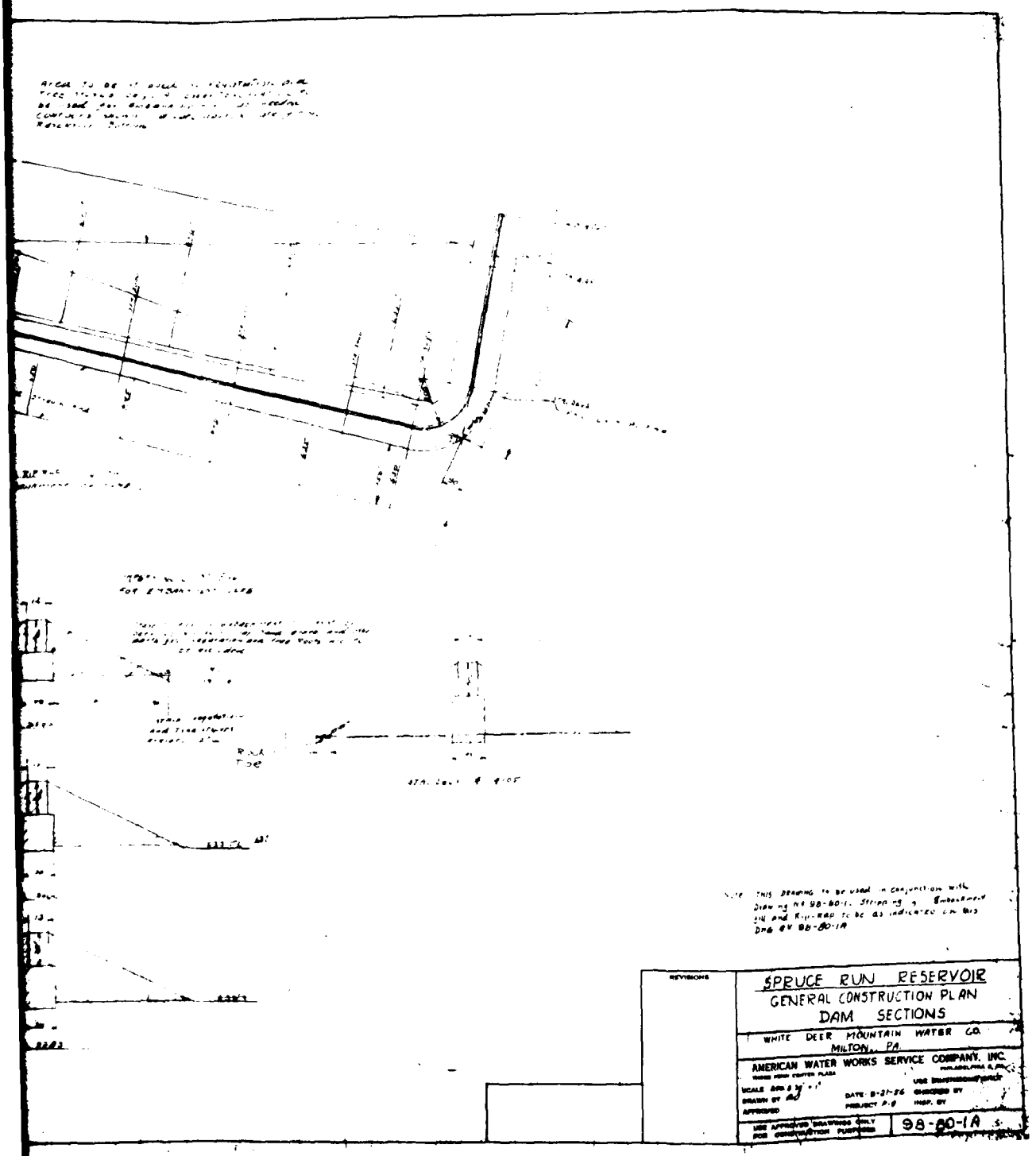
SCALE - As shown — MARCH 8, 1916

METCALF & EDDY
Consulting Engineers
BOSTON CHICAGO

PLATE 3

DRAWN BY	mel	CHECKED BY	DE	2-14-80	DRAWING NUMBER 79-543-B87
	6/11/80	APPROVED BY	[illegible]	7.14.80	





SPRUCE RUN RESERVOIR
GENERAL CONSTRUCTION PLAN
DAM SECTIONS

WHITE DEER MOUNTAIN WATER CO.
MILTON, PA.

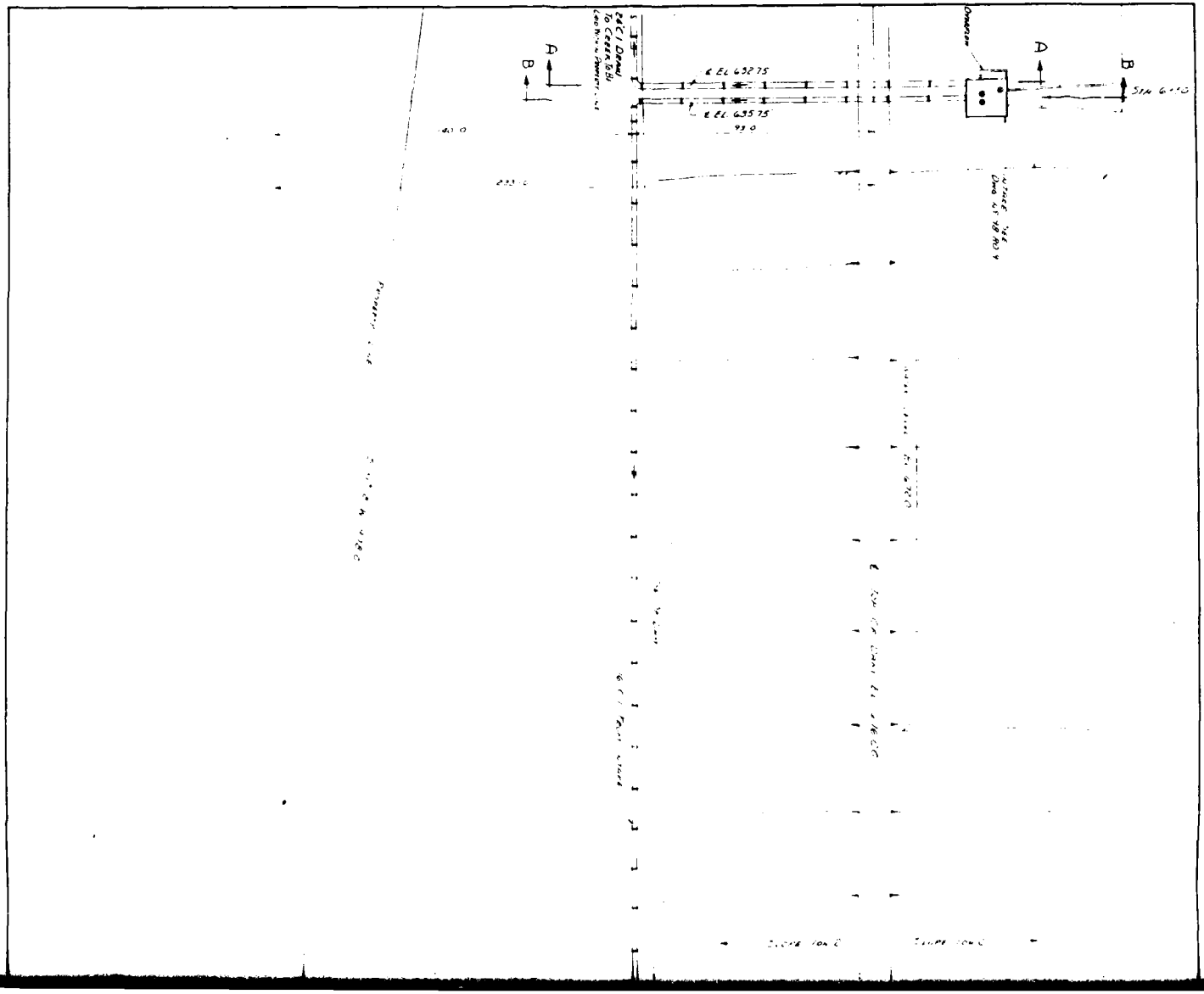
AMERICAN WATER WORKS SERVICE COMPANY, INC.

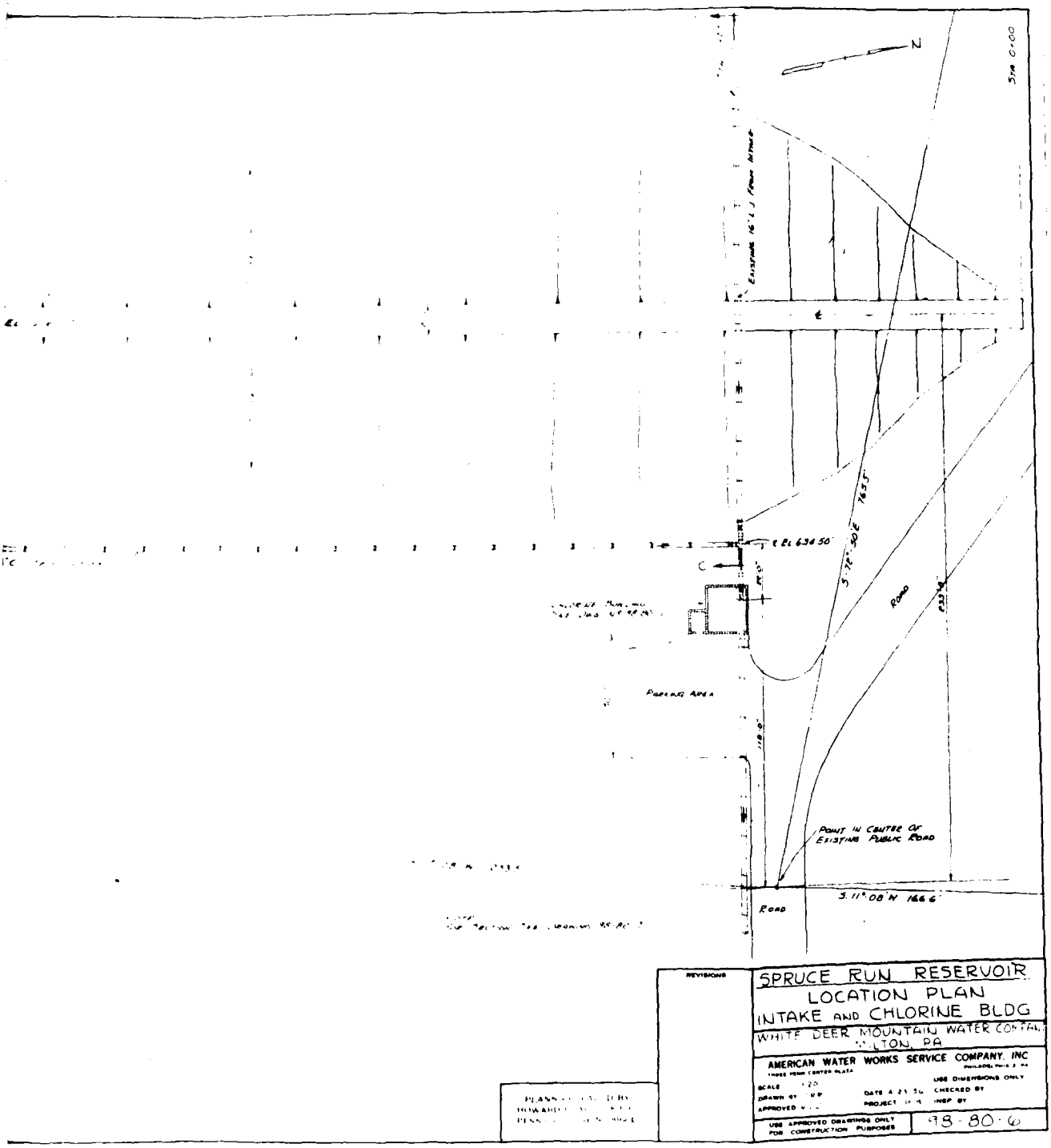
98-80-1A

PLATE 4

D'APPOLONIA

DRAWN BY	mel	CHECKED BY	BE	7-14-80	DRAWING NUMBER 79-543-B88
	6-11-80	APPROVED BY	JHP	7-14-80	





REVISIONS

SPRUCE RUN RESERVOIR
LOCATION PLAN
INTAKE AND CHLORINE BLDG
WHITE DEER MOUNTAIN WATER CONTROL
[illegible]LTON, PA

AMERICAN WATER WORKS SERVICE COMPANY, INC
PHILADELPHIA, PA

SCALE 1"=20'
USE DIMENSIONS ONLY
DRAWN BY [illegible]
DATE 4-21-54
CHECKED BY
APPROVED [illegible]
PROJECT [illegible]
INSP BY

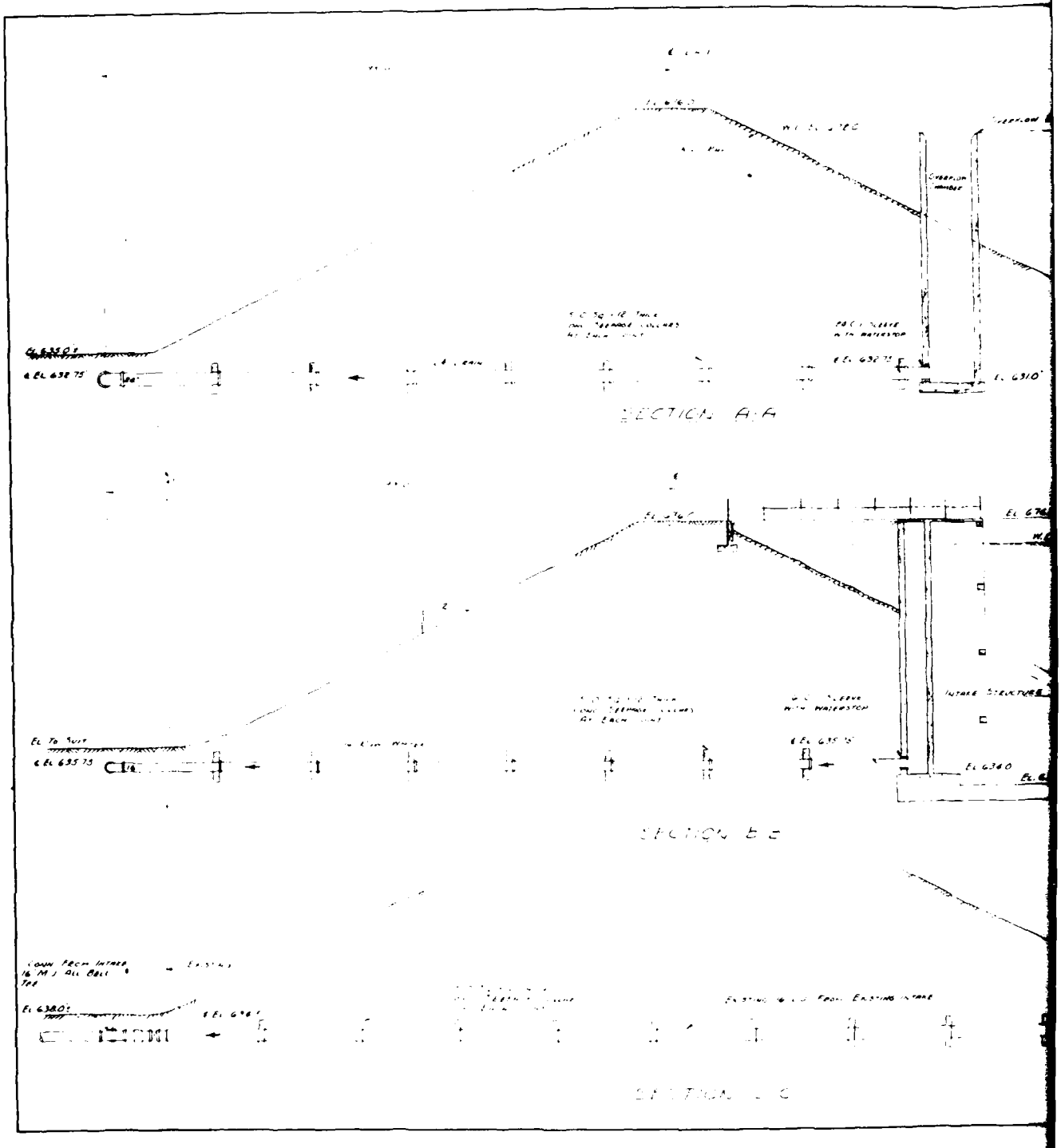
USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES

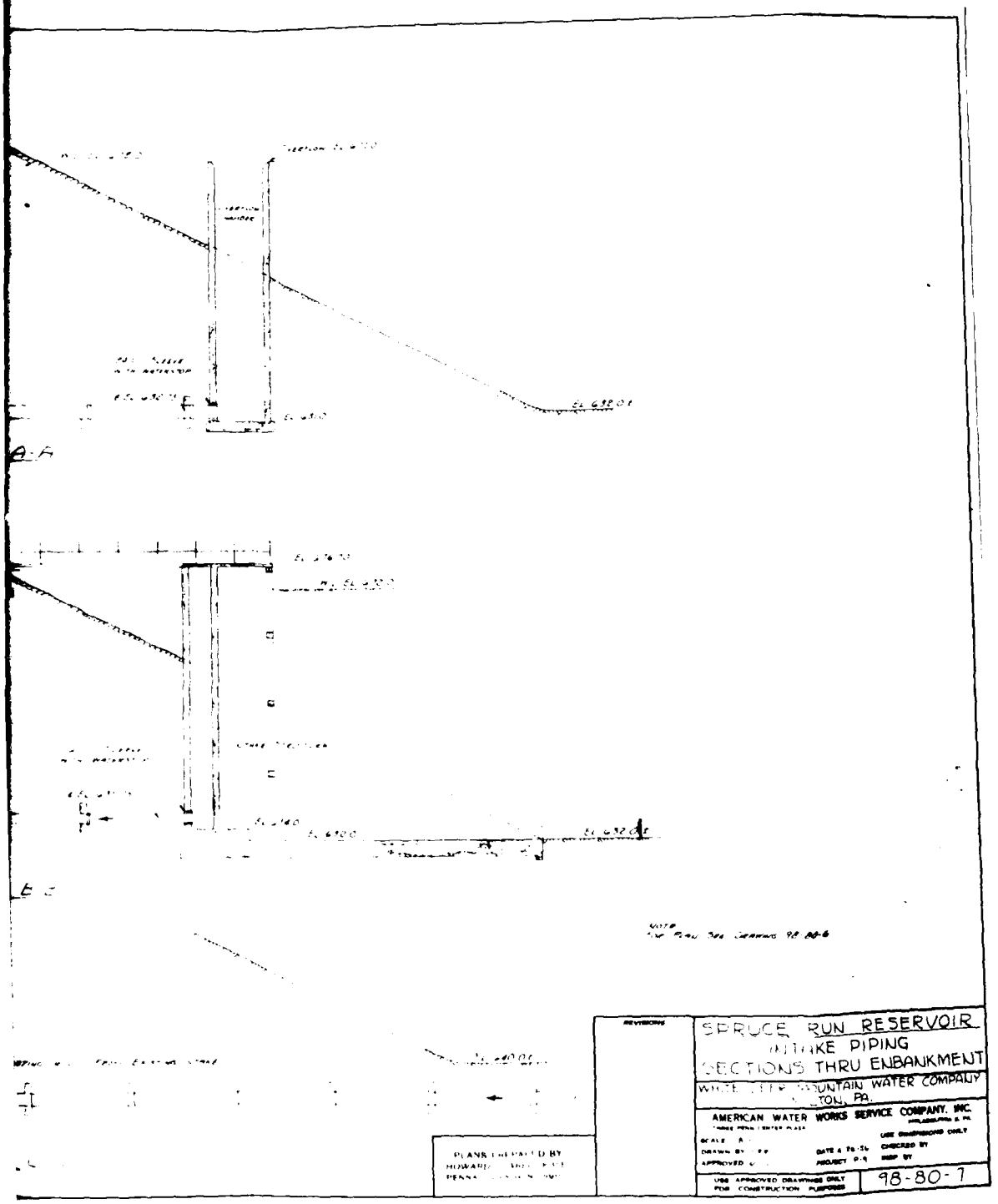
98-80-6

PLATE 5

D'APPOLONIA

DRAWN BY	CHECKED BY	DRAWING NUMBER
mcl 6-11-80	BE 7/14/80	79-543B89
	APPROVED BY 7-14-80	





SPRUCE RUN RESERVOIR
INTAKE PIPING
SECTIONS THRU EMBANKMENT

WHITE DEER MOUNTAIN WATER COMPANY
[illegible]TON, PA.

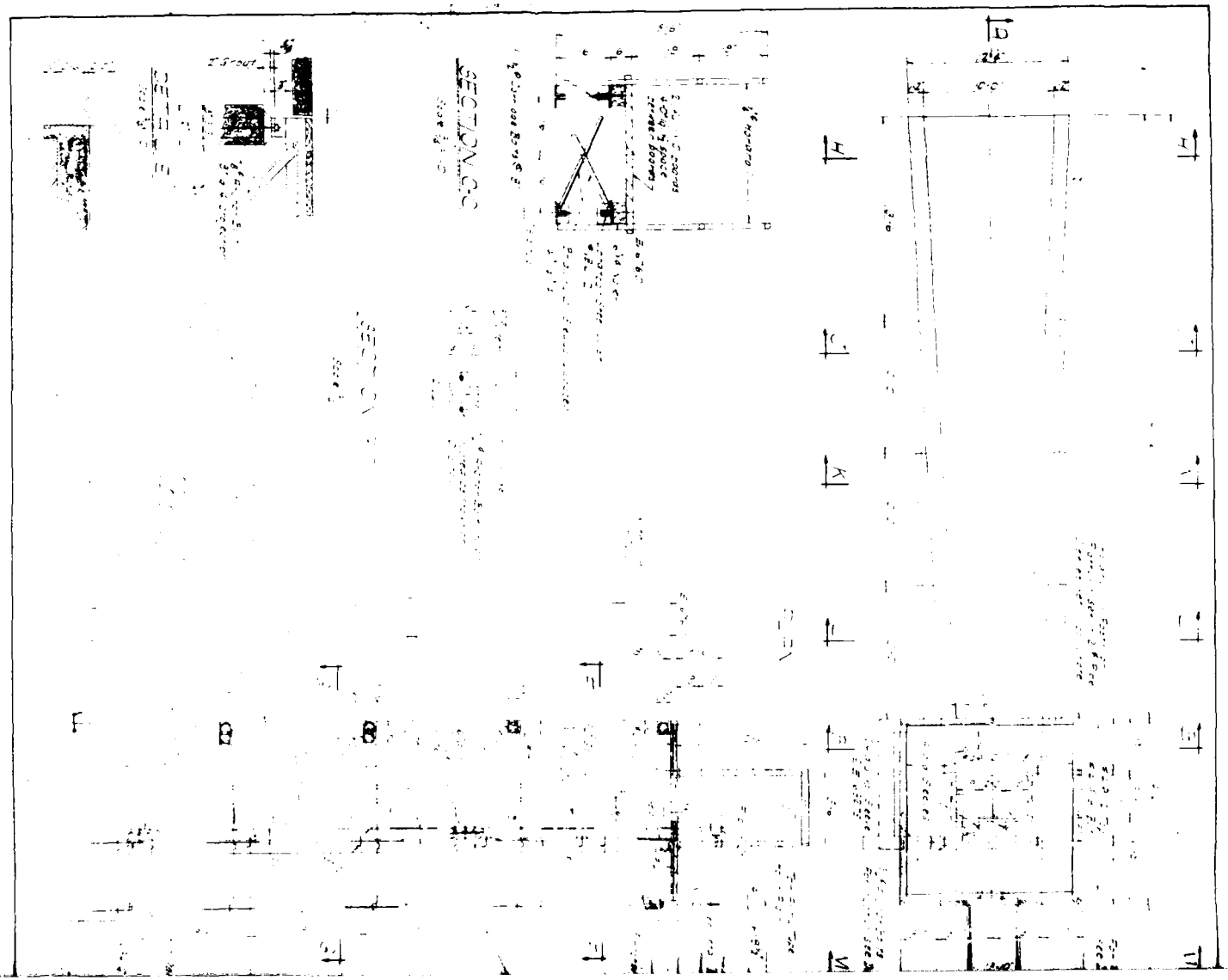
AMERICAN WATER WORKS SERVICE COMPANY, INC.

98-80-7

PLATE 6

DAPPOLONIA

DRAWN BY	mel 6.11.80	CHECKED BY	BE	7-14-80	DRAWING NUMBER 79-543-B90
		APPROVED BY			



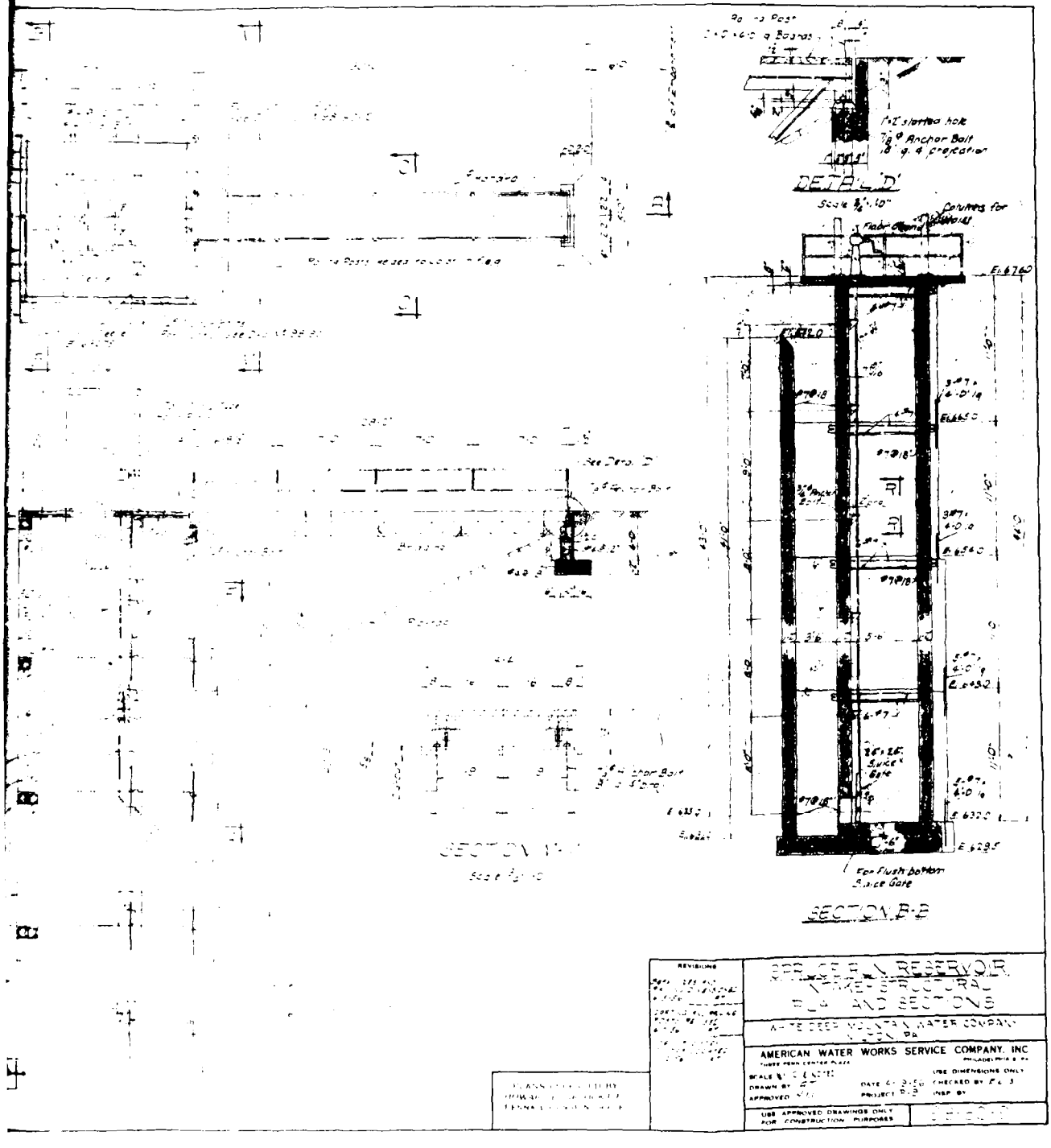


PLATE 7

DRAWING NUMBER	3-A55
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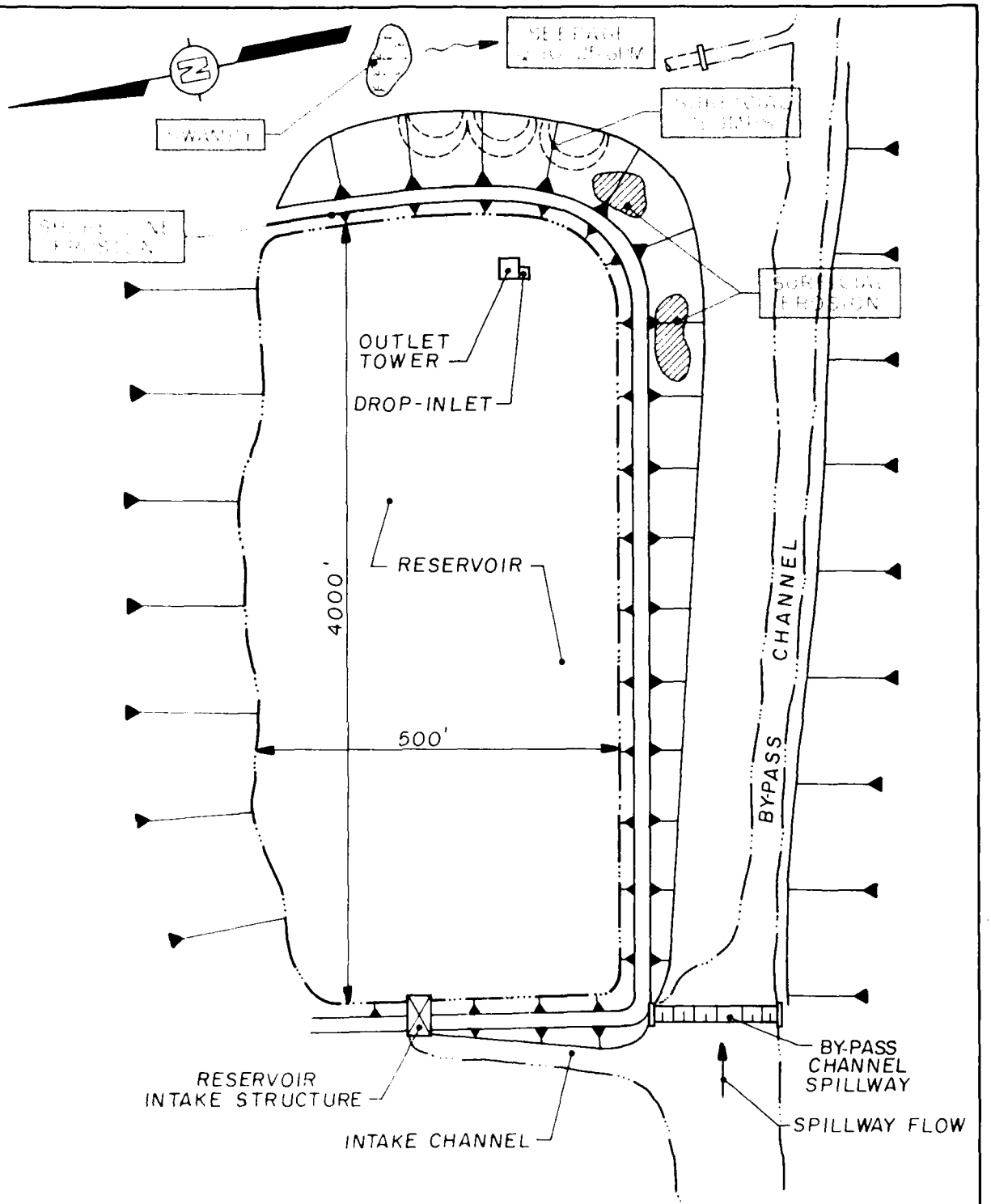
APPROVED BY	
DRAWN BY	ACS
	7-11-80



NOTES:

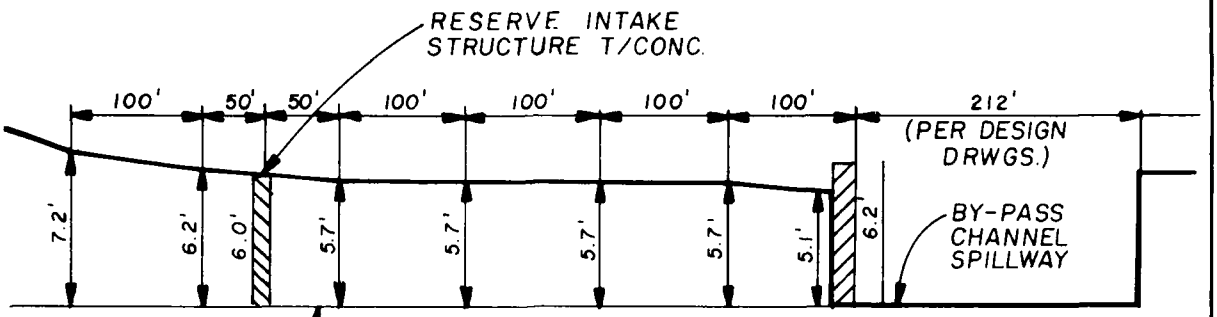
1. POOL LEVEL DATE OF INSPECTION: 23 FT BELOW DROP INLET CREST EL (DROP INLET CREST EL - BYPASS CHANNEL SPILLWAY CREST)

PLATE 8

SPRUCE RESERVOIR
GENERAL PLAN
FIELD INSPECTION NOTES
FIELD INSPECTION DATE: APR 28,1980

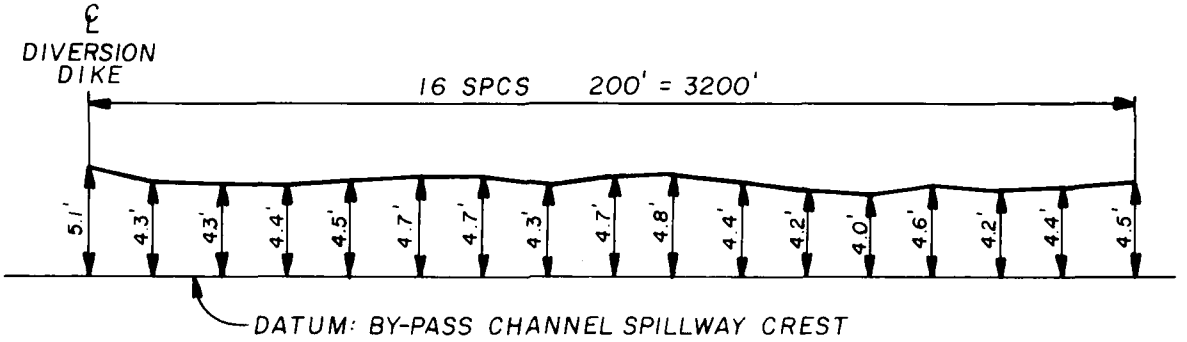
DAPPOLONIA

DRAWN BY	CHECKED BY	DRAWING NUMBER 79- 3-A56
SH 7.10.80	APPROVED BY	7-14-80 7.14 RD



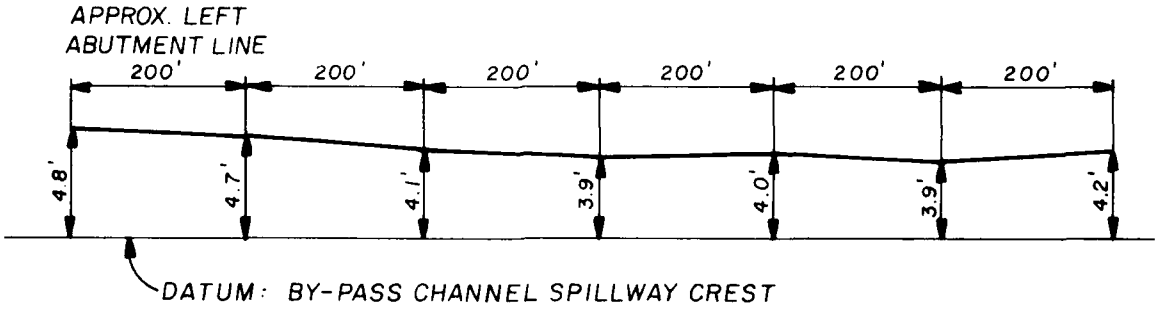
DAM CREST PROFILE

DIVERSION DIKE LOOKING DOWNSTREAM



DAM CREST PROFILE

DIKE ALONG BY-PASS CHANNEL-LOOKING NORTA



DAM CREST PROFILE

MAIN D/S EMBANKMENT-LOOKING DOWNSTREAM

NOTE:

1. DATUM ELEVATION IS PER DESIGN DRAWINGS.

PLATE 9

SPRUCE RESERVOIR
DAM CREST SURVEY
FIELD INSPECTION DATE: APR. 28, 1980

D'APPOLONIA

APPENDIX F

REGIONAL GEOLOGY

APPENDIX F

REGIONAL GEOLOGY
SPRUCE RESERVOIR

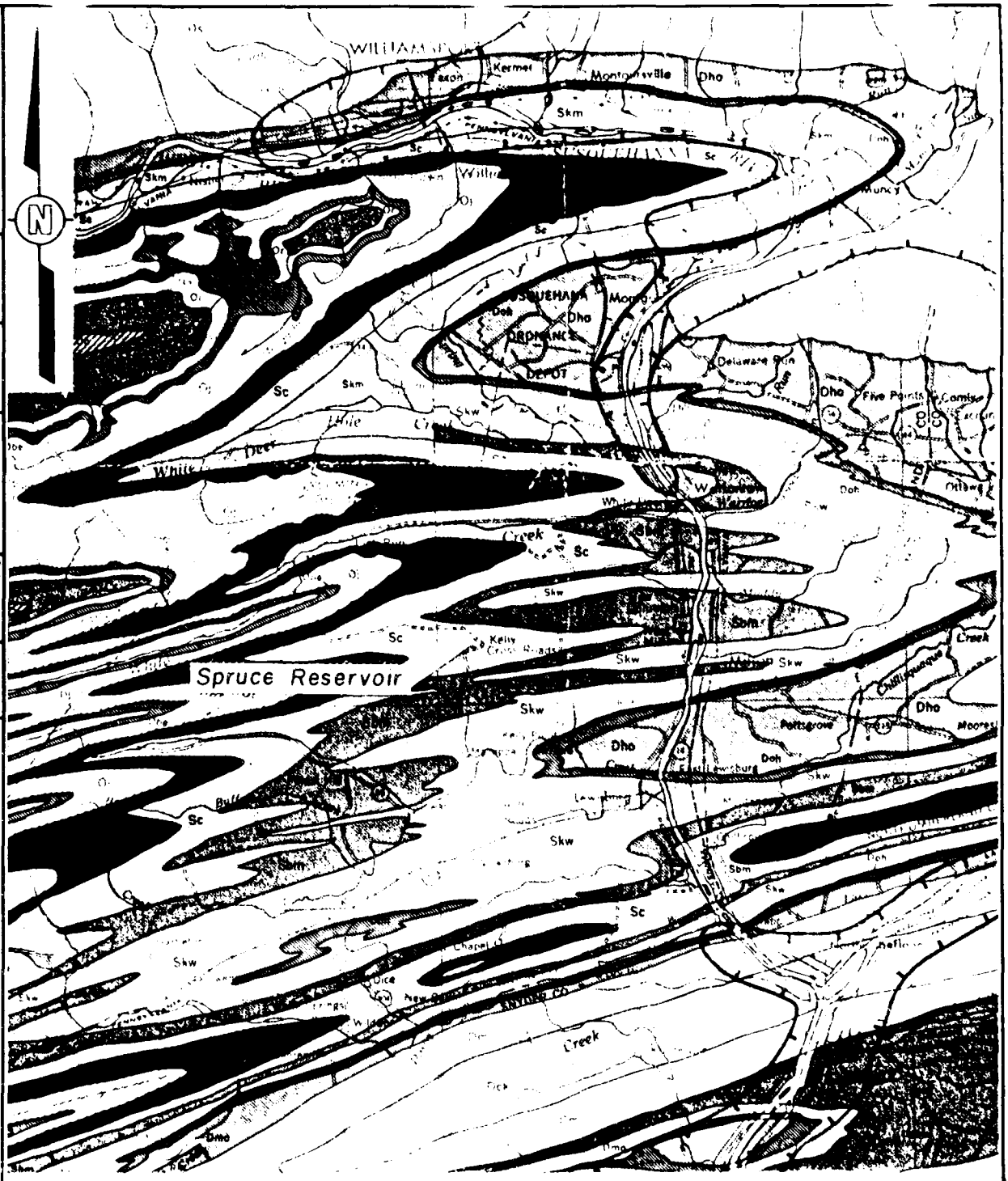
Spruce Reservoir is located in the north-central section of the Valley and Ridge Province. The Valley and Ridge is an area that has undergone moderate to intense folding of strata. The dam is located near the nose of the Buffalo Mountain Anticline which plunges to the east. The dam lies near the contact of the Bloomsburg and McKenzie formations and the Clinton Group.

The Clinton Group is composed primarily by the Rose Hill Formation, a reddish-purple to greenish-gray fossiliferous shale. The shale is fissile and well jointed. The McKenzie Formation is a fissile greenish-gray shale with well-developed joints. The Bloomsburg Formation is comprised of red shale and siltstone with local occurrences of Sandstone. Bedding is fissile to thin and joints are well developed and open.

Strata dip moderately to the north at the dam. Thus, along the north side of the reservoir, strata dip away from the reservoir. Strata dip toward the reservoir along the emergency spillway, an unfavorable situation which enhances the possibility of sliding along bedding planes. However, sliding into the reservoir is minimized by the relatively wide emergency spillway.

DRAWN BY	ACS	CHECKED BY	
	12-31-79	APPROVED BY	

DRAWING NUMBER 75-343-A17



SCALE

0 2 4 6 8 10 miles

REFERENCE

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA., DEPT OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

SPRUCE RESERVOIR

GEOLOGY MAP

DAIPOLONIA

LEGEND

P | **Conemaugh Formation**

Cyclic sequences of red and gray shales and siltstones with thin limestones and coals; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of section; Brush Creek Limestone in lower part of section.

Pottsville Group

[illegible]

Ps | **Allegheny Group**

[illegible]

Sc | **Clinton Group**

Predominantly Rose Hill Formation [illegible] *with dark gray shale (Rochester).*

Marine beds

[illegible]

Pocono Group

[illegible]

Do | **Onesquethaw Formation**

[illegible]

Marcellus Formation

Black [illegible] *thick brown* [illegible] *Tully* [illegible]

Omn | **Onondaga Formation**

Greenish blue, thin bedded shale and dark blue to black, medium bedded limestone with shale predominant in most areas; includes Selinsgrove Limestone and Needmore Shale in central Pennsylvania and Buttermilk Falls Limestone and Esopus Shale in easternmost Pennsylvania; in Lehigh Gap area includes Palmerton Sandstone and Bowmanstown Chert.

Wills Creek Formation

Greenish gray, thin bedded, fissile shale with local limestone and sandstone zones; contains red shale and siltstone in the lower part.

Bloomsburg Formation

Red, thin and thick bedded shale and siltstone with local units of sandstone and thin impure limestone; some green shale in places.

McKenzie Formation

Greenish gray, thin bedded shale interbedded with gray, thin bedded fossiliferous limestone; shale predominant at the base; "intraformational breccia" in the upper part. Absent in Harrisburg quadrangle [illegible]

Keyser Formation

Dark gray, highly fossiliferous, thick bedded, crystalline to nodular limestone; passes into Manlius, Rondout and Decker Formations to the east.

Skt | **Tonoloway Formation**

Gray, highly laminated, thin bedded, argillaceous limestone; passes into [illegible] *beds to the east.*

Dck | **Catskill Formation**

[illegible] *shales and sandstones* [illegible] *gray and greenish sandstone tongues named Elk Mountain,* [illegible] *and Delaware River* [illegible]

REFERENCE

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA. DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1"= 4 MILES

GEOLOGY MAP LEGEND

D'APPOLONIA

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APPROVED BY		1/4/80
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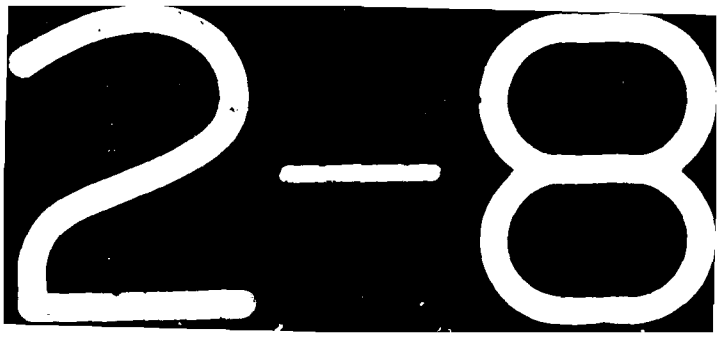
2-8